FOSSIL BENNETTITALES FROM THE TICÓ FLORA, SANTA CRUZ PROVINCE, ARGENTINA

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By CARLOS ALBERTO MENÉNDEZ

SYNOPSIS

This paper deals with the Bennettitales of the Ticó fossil flora located 160 km. north-west of Port San Julian in the Province of Santa Cruz, Argentina. The group is represented by seventeen species of which thirteen are new; they are referred to seven genera (*Otozamites*, *Dictyozamites*, *Ptilophyllum*, *Pterophyllum*, *Zamites*, *Williamsonia* and *Cycadolepis*). All the species, except *Ptilophyllum hislopi*, were found with cuticle preserved.

The fossil plants described indicate in general an age between Upper Jurassic and Lower Cretaceous. On the basis of all the known species so far recorded in the Ticó flora a Wealden age may be postulated.

I INTRODUCTION

THE material described in this paper was collected at Ticó and adjacent areas, approximately in 48° 50′ S. lat. by 69° W. long., nearly 160 km. north-west from the Port of San Julian in the Province of Santa Cruz, Argentina.

The flora was discovered by Dr. J. M. de Giusto, geologist of Yacimientos Petrolíferos Fiscales, and sample impressions on a coarse dark grey sandstone were sent to me by Dr. T. Suero for study. In subsequent excursions undertaken by Dr. S. Archangelsky and the writer, new deposits were found containing specimens with preserved organic remains. The organic remains consist of epidermal cuticles and integuments of seeds, spores, etc. some of which were preserved in such a way that they could be studied microscopically without previous treatment. In a few cases the carbonized parts of the wood parenchyma were also preserved. Brief maceration of the material with nitric acid and potassium chlorate followed by ammonia was all that was necessary to obtain good clean preparations and these were mounted in glycerine jelly.

The preservation of the plants is not the same in all the deposits. In some no cuticle is preserved and the impression of the plant on a tufaceous clay or coarse sandstone is all that remains.

The numerous outcrops in the area contain abundant plant remains which belong to a rich flora and a complete study of the material will demand extensive research. Some of the conifers, six fern-like fronds and a small fruit, have already been described and figured by Archangelsky (1963) as a first contribution to the knowledge of this flora. The following species were described: *Ticoa harrisii* Arch., *T. magnipinnulata*

Arch., *Ruflorinia sierra* Arch., *Mesodescolea plicata* Arch., *Mesosingeria coriacea* Arch., *M. herbstii* Arch., *Ktalenia circularis* Arch., *Brachyphyllum brettii* Arch., *B. mucronatum* Arch., *B. mirandai* Arch., male cones associated with *B. mirandai*, *B. irregulare* Arch., *Athrotaxis ungeri* (Halle) and *Tomaxellia degiustoi* Arch.

With only partial knowledge of this rich flora it has not yet been possible to determine its exact age, but a preliminary consideration of the possible age, based on the fossils now known, is given at the end of this paper.

II SYSTEMATIC DESCRIPTIONS

BENNETTITALES

Genus *OTOZAMITES* Braun

Otozamites parviauriculata sp. nov.

(Pl. 1, figs. 1–3 ; Pl. 2, figs. 7, 8 ; Text-figs. 1–7)

Diagnosis. Leaf up to 4·5 cm. wide, narrower below ; pinnae up to 23 mm. × 7 mm., and at an angle of about 80° to the rachis, varying from slightly separated to slightly overlapping. Pinna margins nearly parallel, shape slightly curved to make the obtuse apex point somewhat forwards ; attachment by middle of basal margin, auricle very little developed. Veins radiating almost symmetrically from region of attachment, forking to maintain a concentration of about 35 per cm.

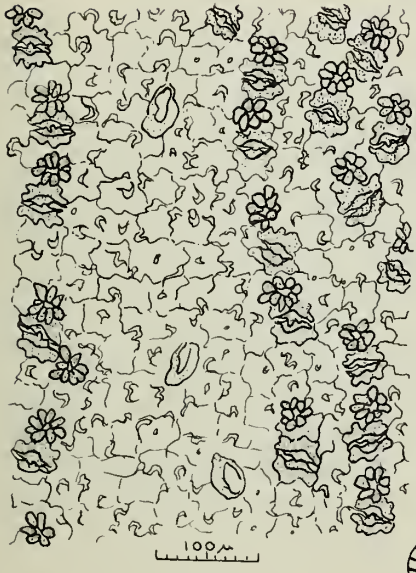
Upper cuticle showing nearly uniform cells in more or less definite longitudinal rows, cells short, anticlinal walls well marked, strongly sinuous, interior of cell flat. Stomata and trichomes absent. Lower cuticle showing stomata in bands between veins. Epidermal cells both along and also between veins tending to be short and rectangular ; anticlinal walls rather finely marked or indistinct, coarsely and irregularly sinuous, much less sinuous than on upper side.

Epidermal cells both along veins and between veins bearing on their surfaces one or more papillae ; papillae not median in position ; hollow and appearing as a ring. Trichome bases consisting of one or two cells with a thickened surface and a large ring-shaped scar occasional along the veins.

Stomata orientated transversely to veins ; irregularly spaced but often forming longitudinal files. Guard cells sunken in a rectangular chamber, mouth of chamber not placed over guard cells ; strongly constricted by a rosette of about twelve small papillae. Guard cells well cutinized ; subsidiary cells extending well beyond guard cells, each bearing a papilla over aperture of guard cells.

Holotype. LIL no. 2600 (Instituto Miguel Lillo, Tucuman).

Figs. 1–7. *Otozamites parviauriculata* sp. nov. Fig. 1. Details of nervation of pinnae. LIL 2600. Figs. 2, 3. Diagrams showing the form of the pinnae. LIL 2600 and V.45372. Fig. 4. Stoma sunken in the bottom of the outer stomatal chamber with its aperture encircled by a crown of papillose cells. LIL 2600. Fig. 5. Section of stoma. Fig. 6. Lower epidermis with stomata aligned in spaces between nerves, hairs and numerous papillae. LIL 2600. Fig. 7. Upper epidermis. LIL 2600.



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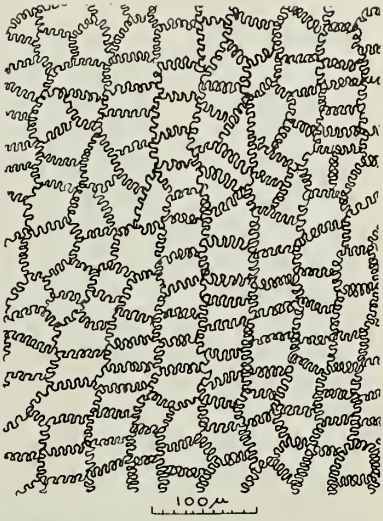

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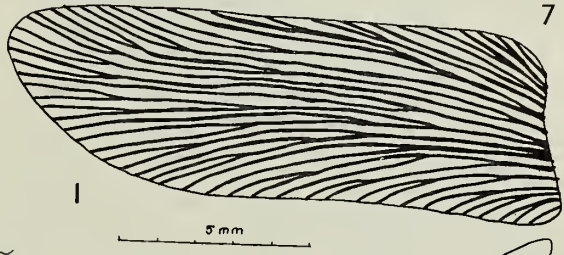

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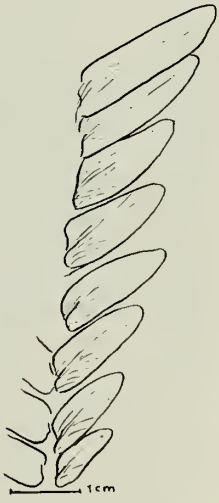

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Other material. British Museum (Nat. Hist.) No. V.45372 ; BAPB nos. 7661, 7909, 7963 (Mus. Argent. Cienc. Nat. Palaeobot.).

Description. All the specimens are figured and all have very similar cuticles except that in Pl. 1, fig. 2 which has rather longer cells and the specimen in Text-fig. 3 which is preserved in a coarse sandstone just above the others and has no cuticle. At the pinna margins the epidermal cells become more elongated.

Comparison. Rather similar stomata are known in other species of *Otozamites* for example *O. pterophylloides* (Florin 1931), *O. beani* and *O. graphicus* (Harris 1944, 1950), but in none of these is the rosette round the aperture of the pit so well marked, nor do the subsidiary cells bear conspicuous papillae. The pinnae in these three European species are of different shape and have better developed auricles.

Of comparable specimens from S. America ; *O. genuensis* Feruglio (1934) from the Lias of Rio Genua, Chubut (which is based on a single fragment of unknown structure) has rather broader pinnae. The specimens determined as *O. obtusus* L. & H. by Ferello (1947) have pinnae of similar size but larger auricles and more divergent veins. *O. obtusus* L. & H. (=*O. bechei*) from the type locality (see Harris 1961) differs both in shape of the pinnae and in cuticle. The specimens from Mexico determined by Wieland (1914) as *O. reglei* var. *lucerensis* are larger with more widely spaced veins.

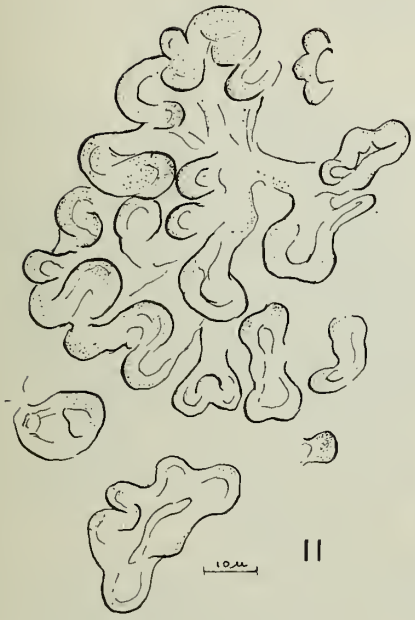
Otozamites grandis sp. nov.

(Pl. 1, figs. 4–6, Pl. 2, figs. 9, 10 ; Text-figs. 8–12)

Diagnosis. Leaf up to 12 cm. wide. Pinnae coriaceous, from 23 mm. × 9 mm. to 60 mm. × 20 mm., arising almost at right angles to the rachis, contiguous or slightly overlapping, margins nearly parallel, apex obtuse, very slightly curved forwards. Pinnae attached to upper surface of rachis but leaving much of this surface exposed, region of attachment middle third of the pinna base. Auricle only very slightly developed, basal angle rounded. Veins radiating almost symmetrically, forking to maintain a concentration of about 20 per cm. Upper cuticle almost uniform. Cells rectangular or of irregular shapes, anticlinal walls strongly marked, rather closely sinuous, leaving much of cell surface unmarked and flat. Lower cuticle thinner, anticlinal walls of cells less clearly marked, only slightly and irregularly sinuous except near pinna margins.

Cells along veins bearing clusters of hollow papillae or a large compound papillae, cells between veins bearing a small papilla cluster or single hollow papillae or with none.

Figs. 8–12. *Otozamites grandis* sp. nov. Fig. 8. Details of nervation of pinnae. Fig. 9. Upper epidermis. B.M. (N.H.), V.45370. Fig. 10. Lower epidermis showing stomata in longitudinal rows, papillose trichomes and papillae. V.45370. Fig. 11. Clustered papillose trichomes. V.45370. Fig. 12. Stoma and papillae. V.45370.



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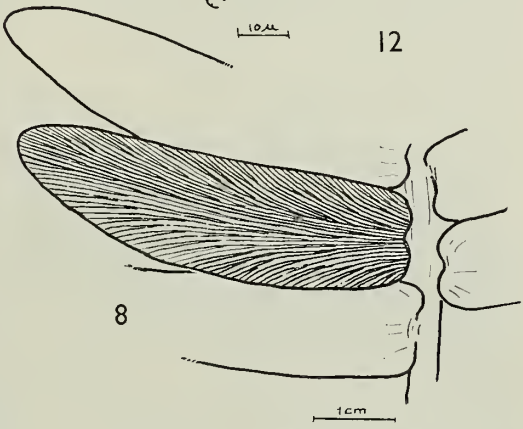

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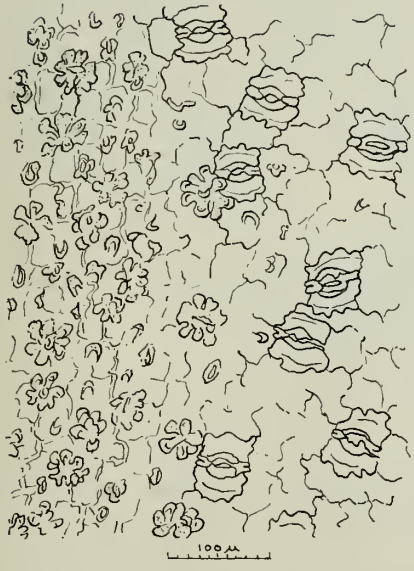

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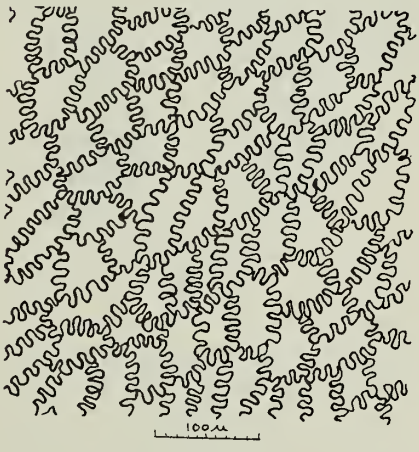

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Stomata occurring in broad bands between veins, occasionally along veins, transversely orientated but irregularly spaced and not forming files. Guard cells level with epidermal surface thickly cutinized. Subsidiary cells rather broad, outer anticlinal walls very broad and prominent.

Holotype. LIL no. 2590.

Other material. In addition to the holotype, BAPB 7964–65, 7967–69 ; Brit. Mus. (Nat. Hist.) nos. V.45370–71 ; LPPB 5900 (Mus. Cienc. Nat. La Plata).

Description. There are a few specimens in addition to those figured ; of those which are not illustrated LPPB 5900 has pinnae 5 cm. × 1·3 cm. and is like the holotype except that the pinnae have slightly more acute apices. Specimen BAPB 7966, with pinnae measuring 5·5 cm. × 1·5 cm., shows the whole width of the rachis (5·5 mm.). Its surface shows longitudinal striae and irregular furrows. BAPB 7967 has the smallest pinnae (2·3 × 0·9 cm.) and BAPB 7965 perhaps the largest, has a pinna fragment 2 cm. wide. The largest fragments are up to 15 cm. long and from the diminution of the size of the pinnae it is probable that the leaf was lanceolate and 30–45 cm. long.

Discussion. *O. grandis* (like *O. parviauriculata*) is remarkable for the almost symmetrical attachment of the pinnae which thus approach the genus *Zamites*. The compound papillae are a remarkable feature of this species.

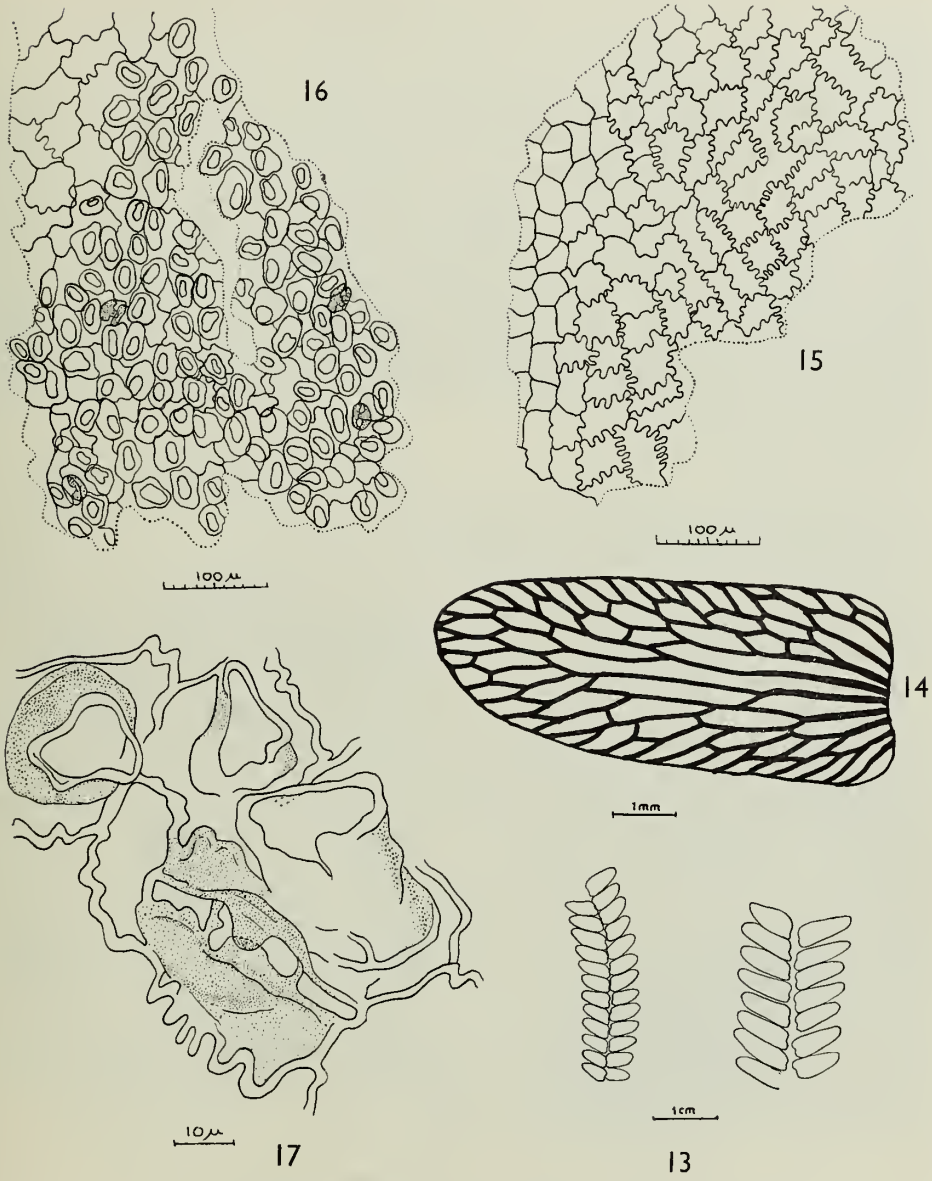
Comparison. No *Otozamites* (or *Zamites*) species is known with pinnae of this size, shape and cuticle. A few species of undescribed structure match *O. grandis* more or less in form. These include *O. giganteus* Thomas 1911 (Middle Jurassic of Kamenka, Russia). Unfortunately the pinna apex is not known so that even the gross features are imperfectly comparable. Specimens from the English Wealden determined by Seward (1895) as *O. klipsteinii* (Dunker) are similar but though the pinnae are as large, they are wider and more obtuse. Even Seward's *O. klipsteinii* var. *longifolius* has wider and more obtuse pinnae than *O. grandis*. *O. oaxacensis* Wieland (1914) from the Lias of Mexico has pinnae of similar size and general shape but with much more acute apices.

Genus ***DICTYOZAMITES*** (Oldham)

Dictyozamites minusculus sp. nov.

(Pl. 3 ; Text-figs. 13–17)

Diagnosis. Leaf 1–3 cm. broad, lanceolate (?) ; pinnae up to 21 mm. × 3 mm. ; smaller ones 5 mm. × 3 mm. Pinnae arising at an angle of 60°–90° to the rachis, typically just in contact. Margins straight and parallel for over half the length of the pinna, then converging equally to a rounded apex, or in largest pinnae apex obtuse ; basal margin slightly retuse, attached almost symmetrically to upper surface of rachis in the middle third, both basal angles rounded ; or in obliquely attached pinnae, upper angle reduced. Substance of pinna thick. Veins conspicuous, middle ones almost longitudinal but lateral ones diverging to meet the margins at an angle



FIGS. 13–17. *Dictyozamites minusculus* sp. nov. Fig. 13. Fragments of frond with long and small pinnae. BAPB 7971. Fig. 14. Details of pinna, showing nervation. BAPB 7976. Fig. 15. Upper epidermis showing cell walls becoming less sinuous towards basal part of pinna (left). LIL 2591. Fig. 16. Lower epidermis showing stomata, trichome bases and papillae. BAPB 7976. Fig. 17. Cuticle showing stoma with papillae on the aperture and trichome bases. BAPB 7976.

of about 35°, veins conspicuous, traversing the lamina at a concentration of about 20 per cm., anastomosing, median vein meshes several mm. long but marginal ones about 1 mm. long.

Upper cuticle showing cells with sinuous walls ; cells over veins and near margins elongated ; surface flat (with no papilla ; stomata and trichomes absent). Towards pinna base cells becoming straight walled. Lower cuticle showing cells with sinuous but inconspicuous anticlinal walls. Epidermal cells each bearing a hollow papilla on its surface ; smallest papillae one fifth of diameter of cell, larger ones occupying most of the surface ; free ends of papillae often expanded and overlapping their bases. Papillae less developed towards margins and base of pinna. Stomata scattered in areas between veins, transversely orientated (Pl. 3, fig. 14). Guard cells situated on the surface, well thickened, aperture protected by well developed solid papilla on each subsidiary cell. Subsidiary cells rather small, outer anticlinal walls broad and thick.

Holotype. LIL no. 2591.

Other material. In addition to the holotype, Brit. Mus. (Nat. Hist.) nos. V.45374–75 ; BAPB nos. 7971–72, 7976 ; LPPB 5899.

Description. In addition to the figured specimens there are a number of detached pinnae (the smallest 3·5 × 2·5 mm.) and a few leaf fragments like those figured. Certain rather large specimens are probably of this species but being preserved in a coarse matrix in which fine details have been destroyed, their determination is less secure. In several specimens the cuticle was difficult to detach and prepare.

Comparison. The material is large enough to show a moderate range of form, mainly in the size of the pinnae and in the angle of their insertion. *D. minusculus* is distinguished from the Indian specimens of *D. falcatus* (also called *Dictyopteris falcata* var. *obtusa*) and *Dictyozamites indicus* see Oldham & Morris (1863), Feistmantel (1877*a*) by never having falcate pinnae. A specimen figured by Feistmantel (1878, pl. 3, fig. 3, 3*a*) is less different but most of the associated specimens are broader. It appears that in *D. minusculus* the pinnae are of constant width over the whole leaf, but in the Indian specimens the width varies with the position on the rachis. The specimens from Bahia Tekenika, Tierra del Fuego (Halle 1913) determined as *D.* cf. *falcatus* also have falcate pinnae. *D. hallei* Sahni & Rao (1936) and Jacob (1951) has even narrower pinnae, 12–15 mm. × 2 mm., and they are also falcate. *D. johnstrupi* (see Nathorst 1907) from the Jurassic of Bornholm has larger pinnae and *D. hawelli* (see Seward 1917) have larger pinnae and the cuticles are distinguished by the much smaller papillae on the lower side.

Dictyozamites crassinervis sp. nov.

(Pl. 4, fig. 16 ; Pl. 5, figs. 21, 22 ; Text-figs. 18–20)

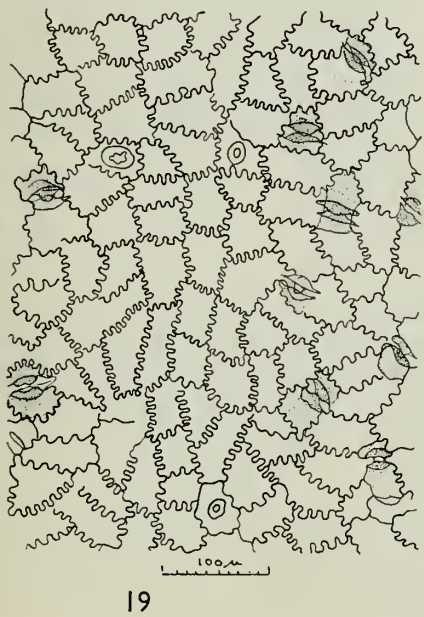
Diagnosis. Leaf about 11 cm. wide. Pinnae arising at about 80°, almost in contact. Pinnae about 6 cm. × 2·5 cm., margins parallel over most of the pinna (apex not known), basal margin truncate, both basal angles rounded, similar or

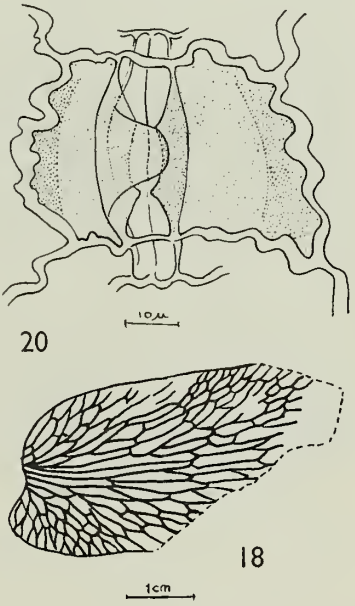
lower one enlarged. Veins arising from a small part of middle of basal margin, thick, middle ones longitudinal and parallel but lateral ones curving out to meet the margins at an angle of about 45°. Veins traversing lamina at a concentration of 6–10 cm. ; in middle of pinna meshes 1 cm. or more long but towards margins meshes reduced to 2–3 mm. Upper cuticle showing sinuous walled cells, somewhat elongated along veins, without papillae, stomata absent, a few trichome bases present. Lower cuticle divided into stomatal areas between veins and strips along veins with none. Cells along veins somewhat elongated longitudinally, cells between veins variable but often transversely elongated ; anticlinal walls of all cells conspicuous, rather finely sinuous interiors of cells usually flat but a few cells showing a small solid papilla.

Stomata on surface, scattered in areas between veins mostly orientated transversely to veins. Guard cells well cutinized, subsidiary cells small, with thick outer walls usually with one or two papillae projecting over the aperture, but occasionally with no papillae. Trichome bases occasional on veins and among stomata, consisting of normal sized cell with thickened surface.

HOLOTYPE. BAPB no. 7979.

OTHER MATERIAL. In addition to the holotype, one specimen BAPB no. 7970.





FIGS. 18–20. *Dictyozamites crassinervis* sp. nov. Fig. 18. Fragment of pinna showing details of nervation. BAPB 7970. Fig. 19. Lower epidermis with stomata transversely arranged between nerves, sparse papillae and trichome bases. BAPB 7979. Fig. 20. Stoma from lower epidermis. BAPB 7979.

DESCRIPTION AND COMPARISON. *D. crassinervis* is only represented by the two figured specimens. Unfortunately the apices of the pinnae are missing in both. *D. crassinervis* is like *D. latifolius* in many respects but the veins are much coarser and the meshes much larger. The stomata of *D. crassinervis* sometimes lack papillae altogether, but those of *D. latifolius* are protected by at least two and often by three or four.

Dictyozamites latifolius sp. nov.

(Pl. 4, figs. 17–20 ; Pl. 5, figs. 23, 24 ; Text-figs. 21–24)

DIAGNOSIS. Leaf up to 13 cm. wide. Pinnae up to 6·5 cm. × 3 cm. but often somewhat smaller, shape almost oblong but widest near the base and lateral margins approaching gradually to near the apex and then contracting more rapidly to an obtuse point, acroscopic margin straight or slightly concave, basal margin truncate, attachment by a small area in the middle, basal angles rounded, basiscopic angle slightly expanded.

Pinnae diverging from rachis at an angle of 50°–90°, lateral margins typically in contact. Veins prominent, consisting of about 10 almost longitudinal ones along middle of pinna and lateral ones diverging from it to meet the margins at an angle of about 30° ; concentration about 15 per cm., meshes in middle region 5 mm. or more long, but reduced to about 1 mm. or even less near margins, at basal angles lateral veins curving to run almost parallel with rachis.

Upper cuticle showing rather uniform, slightly elongated cells, anticlinal walls rather coarsely sinuous ; surface flat. Stomata absent, trichome bases consisting of single oval cell bearing ring-shaped scar, occasional.

Lower cuticle showing slightly elongated cells along veins, cells between veins isodiametric or transversely elongated. Surface of most cells flat or very obscurely papillate. Anticlinal walls coarsely sinuous. Papillae normally absent. Stomata numerous confined to areas between veins, orientated transversely, rather evenly spaced. Guard cells strongly cutinized, subsidiary cells rather small, whole surface strongly cutinized and each subsidiary cell bearing a large hollow papilla pointing over the aperture. Adjacent epidermal cells often bearing hollow papillae pointing towards the aperture and often covering guard cell poles ; occasional cells with similar papillae. Unicellular trichome bases scattered, as on upper side.

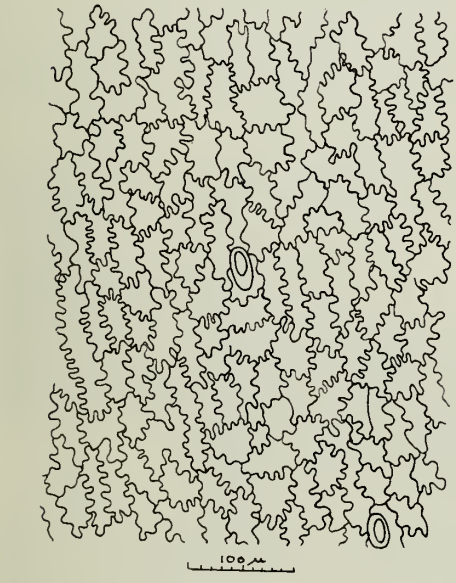
HOLOTYPE. BAPB no. 7995.

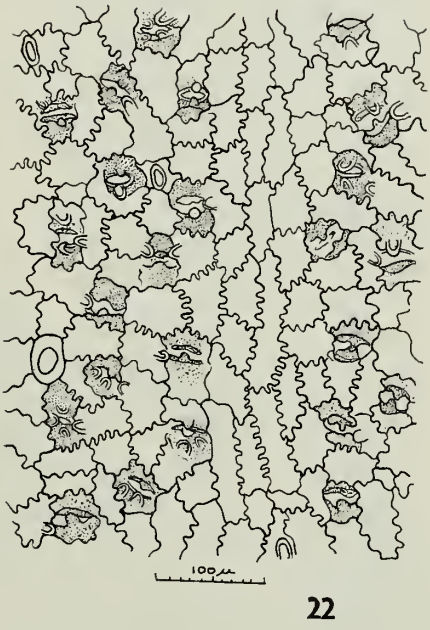
OTHER MATERIAL. In addition to the holotype, LIL no. 2597 ; Brit. Mus. (Nat. Hist.) no. V.45376 ; BAPB nos. 7916–17 ; LPPB no. 5894.

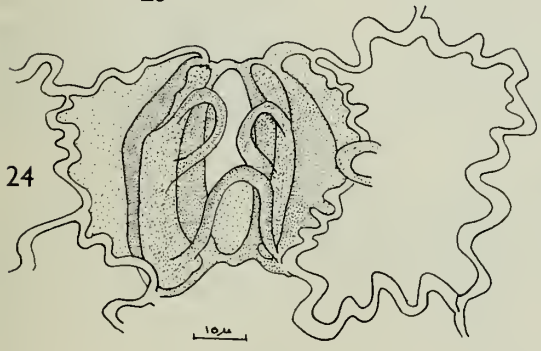
DESCRIPTION. There are five specimens besides the holotype and four are figured. The figured cuticles came from an isolated pinna, the largest specimen (Pl. 4, fig. 17) is preserved in a coarse sandstone and fine details are lost.

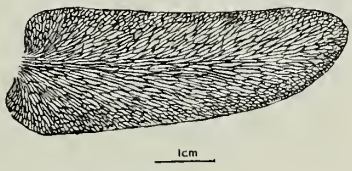
COMPARISON. *D. latifolius* somewhat resembles *D. hawelli* from the English Middle Jurassic, but its pinnae are larger and the lower angles more developed. The leaf determined as *D.* cf. *falcatus* by Halle from the Middle Jurassic of Bahia

Tekenika, Chile differs in its narrower pinnae and expanded upper basal angle which forms an auricle, while the lower one does not. A single fragment determined as *D. falcatus* by Cazaubon (1947) from the Upper Liassic of Esquel, Chubut has pinnae with a more acute apex and more widely spaced veins. The original Indian material of *D. falcatus* described by Oldham & Morris though varied shows more pointed and falcate pinnae.









FIGS. 21–24. *Dictyozamites latifolius* sp. nov. Fig. 21. Details of pinna, showing venation. BAPB 7917. Fig. 22. Lower epidermis, showing elongated cells on nerves and stomata between them. LIL 2597. Fig. 23. Upper epidermis. LIL 2597. Fig. 24. Stoma with papillae on the aperture. LIL 2597.

Genus *PTILOPHYLLUM* Morris

Ptilophyllum longipinnatum sp. nov.

(Pl. 6 ; Text-figs. 25–31)

Diagnosis. Length of leaf exceeding 20 cm., width in middle region about 6 cm., apex rounded, base tapered. Typical pinnae straight, 3 cm. × 3 mm. or less to 4 cm. × 4·5 mm. ; width uniform to near apex or width increasing slightly at first and then narrowing slightly. Pinnae separated by short intervals, attached at an angle of 45° to rachis ; but at a smaller angle near leaf apex, apices of pinnae acute, bases truncate, basal angles rounded or rectangular, not expanded. Veins parallel, at a concentration of about 40–50 per cm.

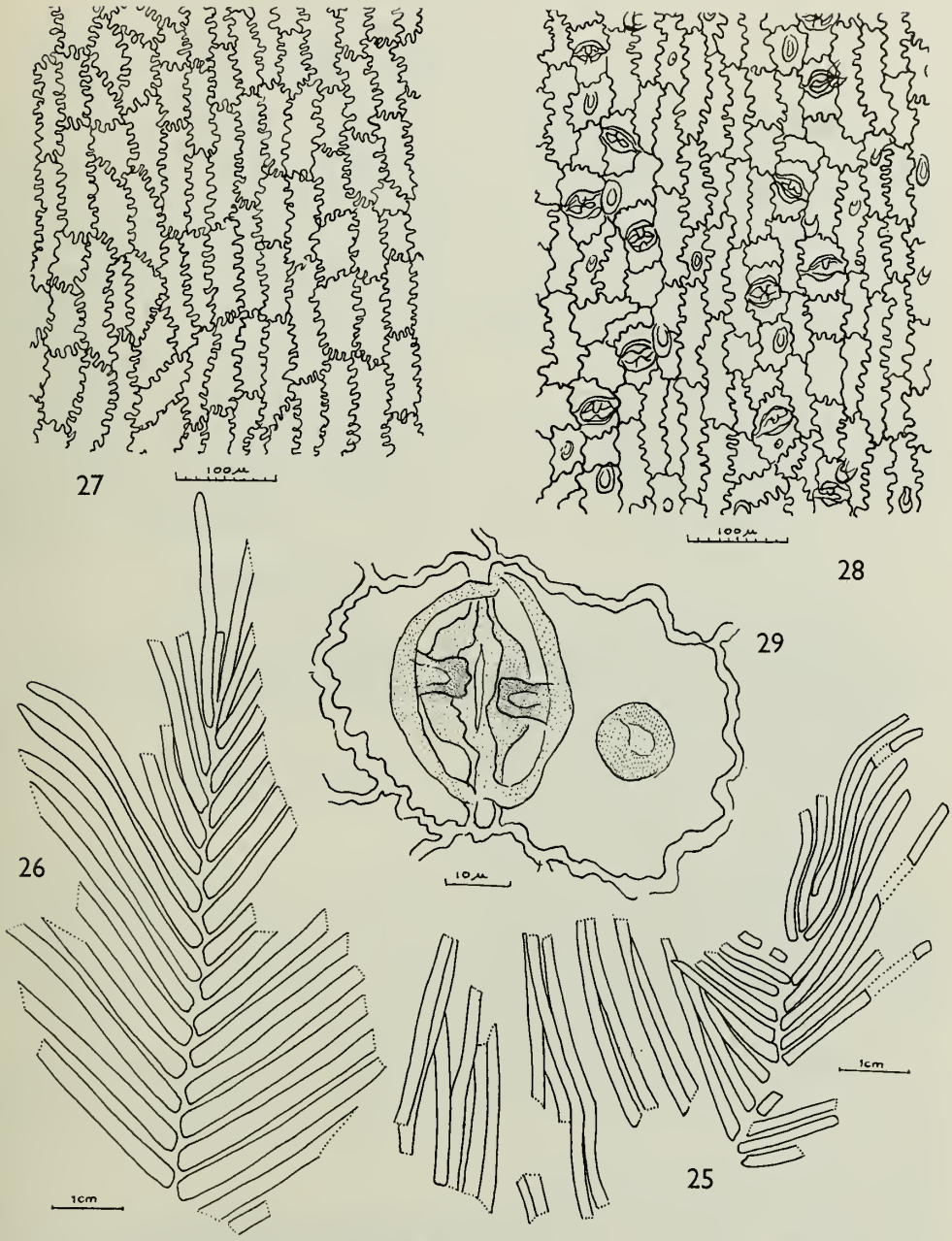
Upper cuticle showing somewhat elongated cells, narrower along veins, anticlinal walls coarsely sinuous, surface flat. Stomata and trichomes absent. Lower cuticle showing similar cells, but anticlinal walls less well marked. Stomata confined to strips between veins, forming about two indefinite files, orientated transversely but irregularly spaced. Ordinary epidermal cells often showing small or medium sized prominent hollow papilla ; towards margins papillae and trichome bases often much more strongly developed, being present on nearly every cell, apices of papillae very thickly cutinized and often distinctly lobed. Guard cells slightly sunken, thickly cutinized, subsidiary cells small with strongly marked entire outer walls and prominent hollow papillae pointing over the aperture.

Holotype. BAPB no. 7940.

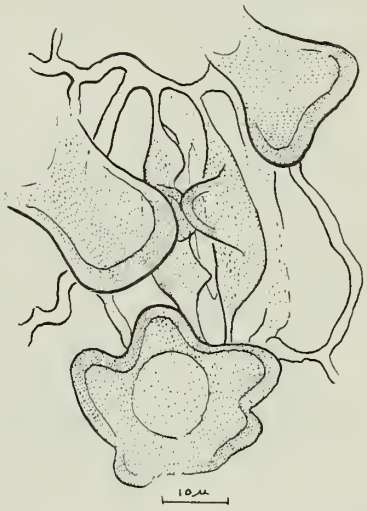
Other material. In addition to the holotype, Brit. Mus. (Nat. Hist.) nos. V. 45377–78 ; BAPB nos. 7943, 7951, 7956–57 ; LIL no. 2595 ; LPPB no. 5898.

Description. *P. longipinnatum* is represented by several specimens besides the holotype. All have long, narrow pinnae, and the most complete, BAPB 7940 (holotype), is a fragment 20 cm. long with pinnae 2·5 cm. long below but increasing to 4 cm. and then decreasing to 3·3 cm., their width is 2·5 cm. throughout. The rachis which is largely concealed is about 2 mm. wide in the lower parts, 1 mm. above.

Comparison. *P. longipinnatum* is not a typical *Ptilophyllum*, and indeed it approaches *Zamites* in the sense in which Halle defined it. However its general characters are perhaps more like those of a *Ptilophyllum* than a *Zamites* and the pinna base is not at all constricted. It is distinguished from all described species of *Ptilophyllum* by its very long, narrow pinnae, as well as from most by the absence of a decurrent basal angle to the pinnae. Its cuticle is distinct ; most of the lower surface is like that of *P. pectinoides* for example, but towards the margin the strongly developed papillae recall those of *P. hirsutum* (see Harris 1949). *Zamites proximus* Feistmantel (1877) from the Jurassic of India has rather similar pinnae but they are contracted at their bases.



FIGS. 25–29. *Ptilophyllum longipinnatum* sp. nov. Fig. 25. Terminal part of a frond. B.M. (N.H.), V.45377. Fig. 26. Fragment of the apical part of a frond. LIL 2595. Fig. 27. Upper epidermis. BAPB 7957. Fig. 28. Lower epidermis. BAPB 7957. Fig. 29. Stoma with papillae on the aperture and isolated papilla. BAPB 7940.



FIGS. 30, 31. *Ptilophyllum longipinnatum* sp. nov. Fig. 30. Lower epidermis from margin of pinna with numerous large papillae. BAPB 7943. Fig. 31. Stoma surrounded by papillae. BAPB 7943.

Ptilophyllum hislopi (Oldham) Seward

(Pl. 7, fig. 29)

The material consists of a number of leaves preserved in a matrix in which the cuticle has been lost. Pl. 7, fig. 29 shows a typical specimen. Another specimen, BAPB 8004, which represents the lower part of the lamina shows pinnae 17 mm. × 4 mm. above decreasing to 14 mm. × 3 mm. below. The rachis is 3 mm. wide below. The veins are seen to be parallel and occasionally forked.

COMPARISON. Since this species is imperfectly known identification must be insecure. Similar leaves (also without microscopic details) have been described under this name from the S. American region. Halle (1913) figured very similar leaves from the Middle Jurassic of Graham Land, and Menéndez (1956) figured another from the Middle Jurassic of Neuquen.

Less similar are the leaves figured as *P. hislopi* by Frenguelli (1935) from the Upper Jurassic of Santa Cruz which have more rigid and acute pinnae. The Ticó specimens agree well in shape with the Indian originals but we have of course no details to compare.

Genus *PTEROPHYLLUM* Brongniart

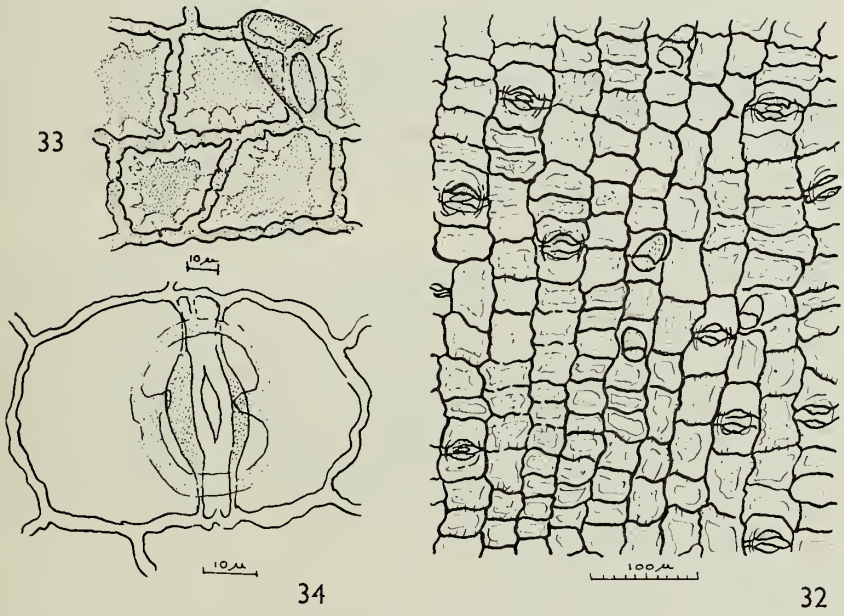
Pterophyllum sp.

(Pl. 7, figs. 30–32 ; Text-figs. 32–34)

DESCRIPTION. The most complete specimen is shown in Pl. 7, fig. 30, unfortunately the apices of the pinnae are missing. The pinnae are attached to the thin rachis by their whole bases. The veins are conspicuous, they fork occasionally and there are 12–14 veins in each pinna. Another specimen, BAPB 7980, shows pinnae 3 cm. long and tapering from 4 mm. at the base to 2 mm. wide towards the free end.

Only the lower cuticle is preserved, its characters are clearly seen in Pl. 7, fig. 31 ; Text-fig. 33. Very small papillae are discernible above the guard cell thickenings in Pl. 7, fig. 32.

COMPARISON. No very similar leaf has been described from Argentina. The leaf determined as *P. rajmahalense* by Kurtz (1921) from Rio Atuel has longer pinnae ; *P. barrealense* Frenguelli (1950) from the Trias of Barreal, San Juan has more widely separated pinnae and *Pterophyllum* sp. Kurtz (1921) from the Trias of Cacheuta, Mendoza has pinnae with more crowded veins and also a broader rachis.



FIGS. 32–34. *Pterophyllum* sp. Fig. 32. Lower epidermis showing transversely orientated stomata, short hairs and cells with thickened surfaces. BAPB 7959. Fig. 33. Details of thickening of surface of cells and a short hair. BAPB 7959. Fig. 34. Stoma showing the thickening of the subsidiary cells and small papillae on both sides of the aperture. BAPB 7959.

The Ticó specimens are not well enough characterized to be worth comparing with leaves from more distant areas.

Genus *ZAMITES* Brongniart

Zamites decurrens sp. nov.

(Pls. 8, 9 ; Text-figs. 35–39)

Diagnosis. Leaf large, rachis up to 8 mm. wide, bearing pinnae laterally, pinnae well spaced. Width of lamina 4–20 cm. Pinnae up to 9 cm. × 8 mm., but in smaller leaves 5·5 cm. × 4 mm. and 2 cm. × 3·2 mm. Pinnae almost straight ; in large pinnae width increasing rapidly from near the base, then parallel then tapering to a rather acute apex. In smallest pinnae width increasing to near the rounded apex and shape thus spatulate. Basal angle always decurrent. Veins nearly parallel, fairly thick, forking occasionally at various levels.

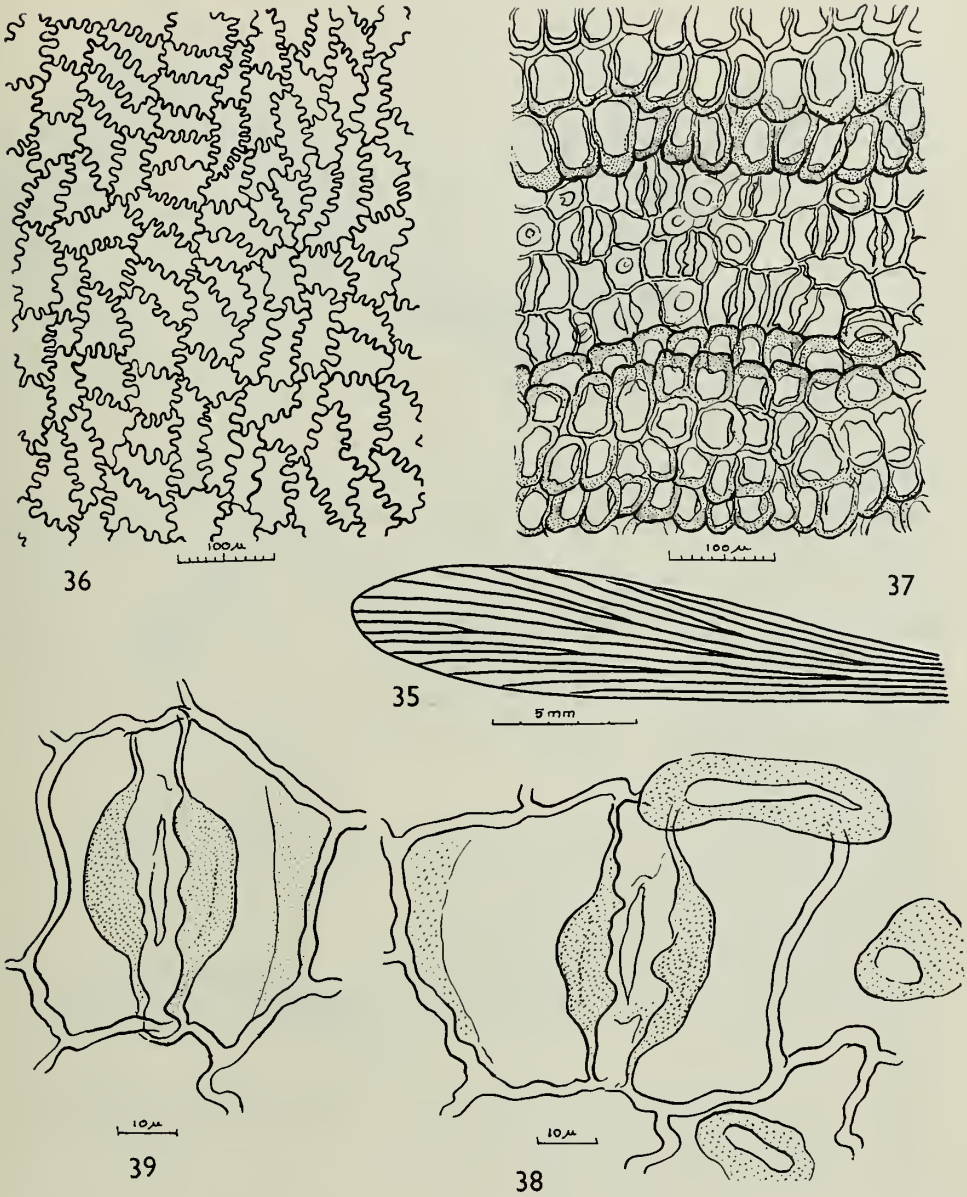
Upper cuticle showing nearly uniform, slightly elongated cells with strongly sinuous lateral walls. Stomata and trichomes absent. Lower cuticle showing folds along the sides of the raised veins. Cells along veins isodiametric, bulging in a globe and appearing thick-walled on compression ; forming well marked longitudinal rows ; trichome bases infrequent. Intervenal areas showing their true walls, approximately square, anticlinal walls straight, surface often occupied by a papilla, papillae hollow, sometimes small but often so large as to occupy the whole surface. Stomata transversely orientated, very numerous, forming well marked longitudinal files, but not quite evenly spaced in the files. Guard cells well thickened, subsidiary cells often as large as ordinary epidermal cells.

Holotype. LIL no. 2596.

Other material. In addition to the holotype, Brit. Mus. (Nat. Hist.) nos. V.45379–80 ; BAPB nos. 7927–28 ; LPPB nos. 5888–89.

Description. The different specimens figured show a remarkable range both in the width of the leaf and in the form of the pinnae, but their very characteristic cuticles are just the same and for this reason they are included in the one species. In every one the lower basal angle of the pinnae is decurrent on to the rachis. The veins are almost parallel and some of the lateral ones end in the margins ; this is most marked in the short pinna shown in Text-fig. 35. The specimen shown in Pl. 8, fig. 34 gives some indication of the length of the rachis, for it tapers in this fragment from 4 mm. to 2·4 mm.

Comparison. *Zamites buchianus* (Ett) from the English Wealden, see Seward (1895) is similar to some forms of *Z. decurrens* but it has longer pinnae. *Z. carruthersi* in the same flora has even larger pinnae. *Z. proximus* Feistmantel (1877) from the Indian Jurassic has narrower and less decurrent pinnae. In *Z. gigas* the pinnae differ in being attached to the top of the rachis. The cells along the veins do not form bulging gloves as in *Z. decurrens*.



FIGS. 35–39. *Zamites decurrens* sp. nov. Fig. 35. Details of nervation of pinna. BAPB 7927. Fig. 36. Upper epidermis. BAPB 7927. Fig. 37. Lower epidermis showing globose cells on the nerves and stomata, hairs and papillae between the nerves. BAPB 7927. Figs. 38, 39. Stomata and papillae on the lower epidermis.

Genus *WILLIAMSONIA* Carruthers

Williamsonia bulbiformis sp. nov.

(Pls. 10, 11 ; Text-figs. 40–53)

Diagnosis. Female 'flower' with (10 to 14?) ribbon-shaped bracts, apices acute, thick, parallel nerved ; adaxial epidermis with thick cuticle, lacking stomata, cells aligned longitudinally, walls straight, cells rectangular, square or polygonal, elongated ; abaxial epidermis with thick cuticle and stomata, cells aligned longitudinally, walls straight, cells rectangular, square or polygonal, shorter than those of the adaxial epidermis ; outer, lateral and sometimes inner walls cutinized, hypodermis present ; epidermal hairs isolated and clustered in more or less transverse rows ; stomata scarce, transversely orientated, 10–14 per sq. mm., syndetocheilic. Guard cells with cutinized walls, subsidiary cells large. Fertile and sterile megasporophylls (interseminal scales) grouped in flattened pyriform cone (gynaecium) ; interseminal scales 4 to 7 mm. long, 1 mm. broad, and 14 mm. long and 3 mm. broad in mature specimens, polygonal in section and in juxtaposition, with apical part convex and well cutinized with a central dome, circular or polygonal in cross-section, 5 or 6 interseminal scales surrounding the fertile megasporophylls which project in surface a micropylar tube. Cells at apical part of interseminal scales straight and thick walled, concentrically arranged, central ones somewhat papillose and the walls thicker than those of marginal zone. Stomata scarce (2–6 per shield), concentrically arranged, generally with their main axis tangential, more rarely radial ; syndetocheilic with heavily cutinized guard cells, sunken, sometimes with papilla on the aperture. Micropylar tubes cylindric, broadening at base with cells longitudinally aligned, rectangular, square or trapezoidal, walls bulging and giving rise to the papillose surface of micropylar tube.

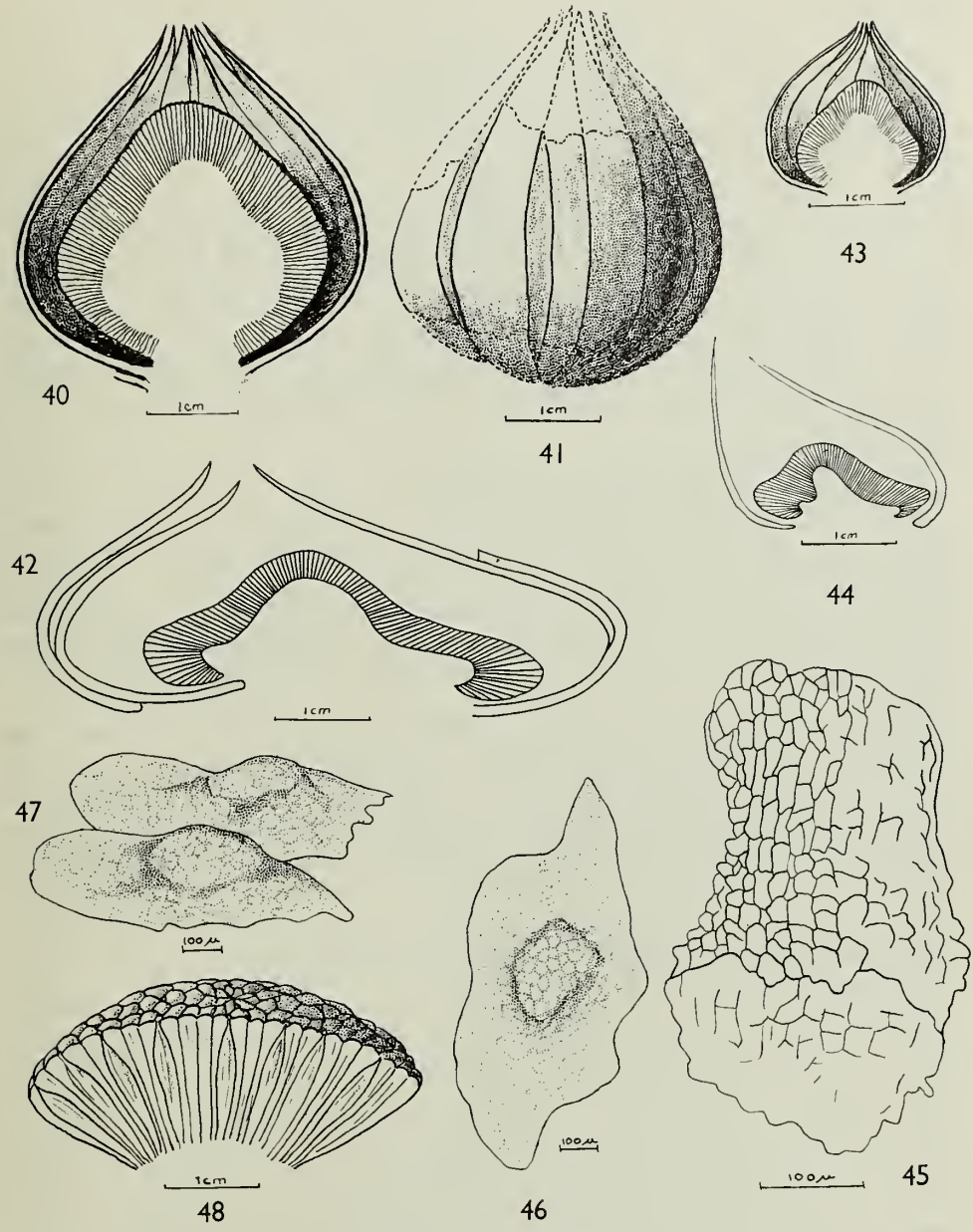
Holotype. LIL no. 2599.

Other material. In addition to the holotype, BAPB nos. 7998–8000 ; Brit. Mus. (Nat. Hist.) nos. V.45381–82 ; LPPB nos. 5896–97.

Description. The most complete specimen is BAPB no. 7998. It has been compressed along its vertical axis which has resulted in the 'flower' having a flattened conical shape, with the apex of the bracts displaced to one side (Pl. 10, figs. 39, 40). The hollow left by the receptacle is pyriform and flattened principally at the base with a maximum breadth of 3 mm. It is surrounded by the interseminal scales which are up to 7 mm. in length.

The bracts have a maximum width of 9–11 mm. at the basal region, decreasing gradually in width towards the apex. The basal part of the specimen is missing so that the length of the bracts can only be estimated as 6 to 7 cm. Some of the bracts were lost through breakage but the number present in the entire specimen was

Figs. 40–48. *Williamsonia bulbiformis* sp. nov. Fig. 40. Reconstructed section of specimen BAPB 7998. Fig. 41. Reconstruction of general aspect of the ' flower '. Fig. 42. Schematic profile of specimen BAPB 7998. Fig. 43. Reconstructed section of specimen B.M. (N.H.) V.45381. Fig. 44. Reconstructed profile of specimen B.M.



(N.H.), V.45381. Fig. 45. Micropylar tube. BAPB 7999. Fig. 46. Apical part of interseminal scale with polygonal umbo. BAPB 7999. Fig. 47. Apical shields of interseminal scales in lateral view, showing the central dome or umbo. BAPB 7999. Fig. 48. Reconstructed section of specimen BAPB 7999.

probably 13–14. Of the 8 remaining, some of them overlap as if there was more than one series probably in helicoidal arrangement.

A diagrammatic reconstruction of this specimen is given in Text-figs. 40 and 42.

The holotype (Pl. 11, fig. 45) is the basal part of a 'flower', the circular area at the centre, which corresponds to the impression of the receptacle, is concave, slightly conical, 18 mm. in diameter, and is dense and finely pitted due to scars of the vascular bundles of the fertile and sterile megasporophylls (interseminal scales). Surrounding the receptacle in a ring are the lateral megasporophylls and interseminal scales in the form of striated tubes, 5 mm. long and 0·5 mm. wide, which appear to be formed from interseminal scales. Covering this ring-shaped zone of the megasporophylls were the bracts that wrap round the 'flower', which, after falling exposed the megasporophylls. On the inner part of the overlapping bracts is engraved the surface of the cone which forms the junction of fertile megasporophylls and interseminal scales. The close arrangement of the latter gives the surface the appearance of a net with polygonal mesh.

Parts of the interseminal scales are frequently found perfectly preserved and in some cases the micropylar tube is also present.

Of the bracts that surrounded and covered the 'flower' only fragments, approximately 5 mm. broad, remain, therefore if in its insertion in the receptacle there was no superposition, there should be a minimum number of from 10 to 11. The bracts are consistent because the organic matter preserved is generally thick but the venation is only faintly visible on the impression because it is embedded in the parenchyma. The faint longitudinal furrows that can be seen in the impressions correspond to the parallel nerves.

Specimen B.M. (N.H.) no. V.45381 (Pl. 10, fig. 41) is a 'flower' in which the impression of the receptacle is finely pitted, the encircling megasporophylls are 4 mm. long. The bracts that surround the 'flower' are from a sector corresponding approximately to one half of the 'flower' and are from 4·5 to 5·5 mm. wide. The most complete fragment of bract is 2·5 cm. long and decreases in width towards the apex, its total length was probably about 3 cm. In this specimen, in spite of the deformation due to compaction, the hollow corresponding to the receptacle has retained an approximately conical shape but with its lateral margins flattened. A diagrammatic reconstruction of the complete 'flower' is shown in Text-figs. 43 and 44.

Specimen B.M. (N.H.) no. V.45382 is the external mould of an aggregate of bracts which shows the ovoid shape characteristic of the closed ' flower ' and this specimen was used to make the reconstruction in Text-fig. 41.

Fructification. Specimen BAPB 7999 (Pl. 10, fig. 42 ; Text-fig. 48) shows an interesting form of preservation ; it is a fragment of a laterally cleaved fructification through a tangential plane and is without bracts. Only the external mould remains of the upper part of the fructification and this is 4·2 cm. in diameter. It bears traces of the cuticle from the outer surface of the sterile and fertile megasporophylls. Casts of the megasporophylls and of the interseminal scales continue under the mould as a result of infiltration of sediment into the tissues. The casts of the fertile megasporophylls are fusiform, longitudinally faceted, with acute apices elongated towards

the external mould at the surface where they correspond to the micropylar tubes. The length of the megasporophylls is 14 mm. and the width 3 mm. in its widest part. This is much larger than the megasporophylls in specimen LIL 2599 which are 5 mm. long and 1 mm. wide and even taking into account that these latter measurements correspond to marginal megasporophylls the size variation is quite striking. One possible explanation is that the larger specimen is a fertilized ' flower ' with developing seeds.

This specimen is included in *Williamsonia bulbiformis* in spite of the considerable difference in size of the interseminal scales, because the cuticle of the upper part of the scale is the same as that of the immature specimens described above.

Cuticle. Cuticles from the apical parts of the interseminal scales are perfectly preserved, but those from the remaining part of the scale which continue below the surface have been found in only one case, and in this region the shape of the interseminal scales is prismatic as a result of close contact between the scales. The cuticle forming the shield at the apex of the interseminal scales usually separates when treated with Schulze's solution, although it sometimes remains united. The shields are polygonal in outline and hemispherical in surface with a central dome or bulge circular in cross section (Text-figs. 46, 47). The straight and thick-walled cells are arranged concentrically around the centre of the shield (Pl. 10, fig. 44 ; Text-fig. 49). In some the main axis of the cells is orientated radially and in others tangentially, but there are also isodiametric cells. The cells are from 20 to 60 μ in length by 15 to 30 μ in width. At the centre they are somewhat papillose and the cell walls thicker than those of the marginal zone.

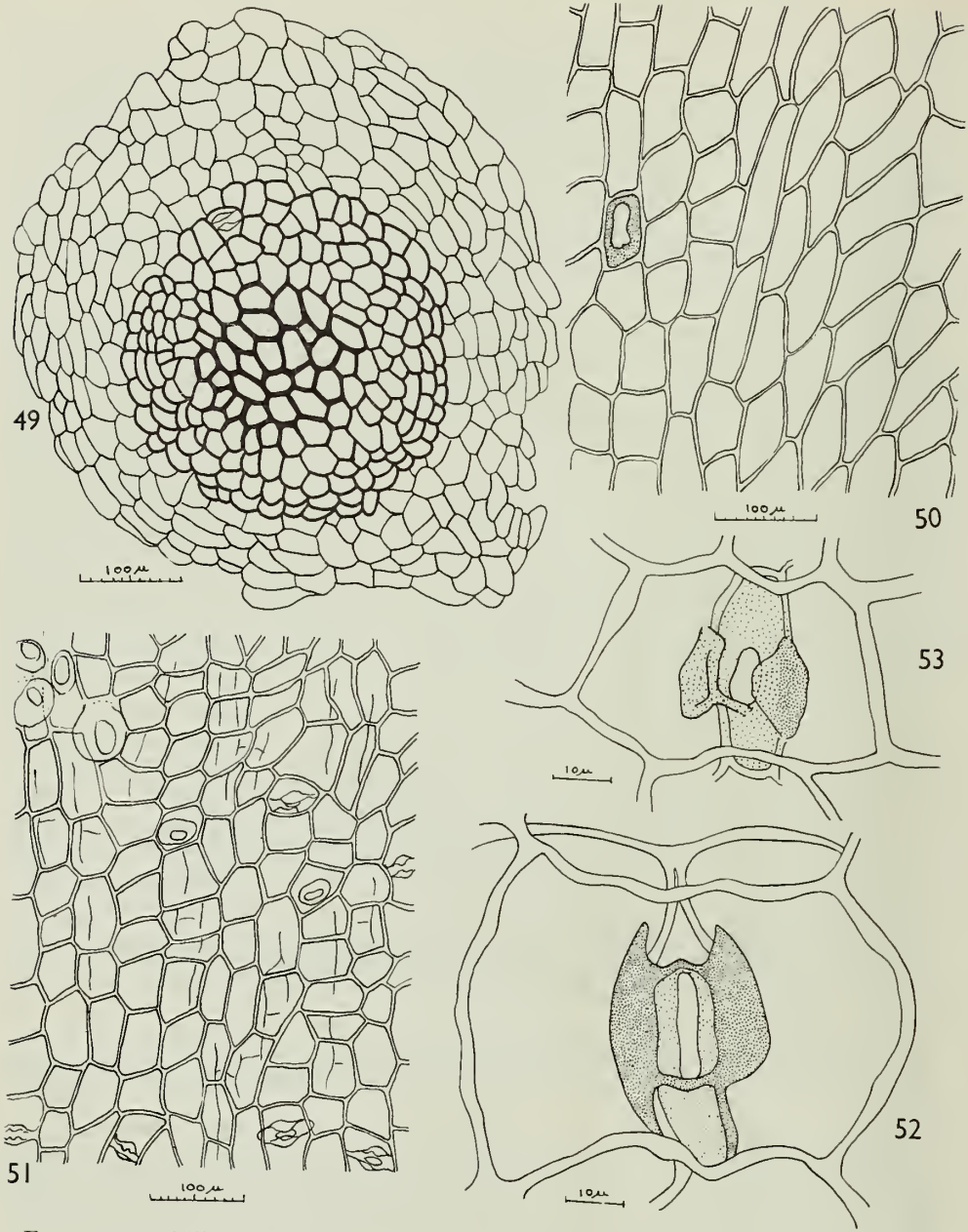
The shields possess from 2 to 6 stomata concentrically arranged both in the elevated zone at the centre and in the encircling zone although more frequently in the latter. The stomata are arranged with their longitudinal axes in a tangential direction or more rarely in a radial direction. They are syndetocheilic and sunken. The walls of the guard cells are heavily cutinized and even thicker than the lateral walls that abut with the subsidiary cells. One stoma was observed in which one papilla projected from a subsidiary cell towards the aperture. The stomata measure between 35 and 45 μ in length.

Five or six interseminal scales surround the fertile megasporophylls and from these, as noted above, the cuticle of the apical part encircling the micropylar tube was obtained.

The arrangement of these parts was only seen in the material before treatment with Schulze's solution, because after oxidation the scales and micropylar tube usually separate.

Only three micropylar tubes were obtained, all from specimen BAPB 7999, and although more than a score of preparations were made from other specimens micropylar tubes were not found. This indicates that the fertile megasporophylls do not occur at random among the interseminal scales but are confined to certain regions.

The micropylar tube (Text-fig. 45) is cylindrical, broader at the base than at the upper end, has a length of 300 μ, a breadth of 280 μ at the base, 200 μ at the narrowest part and 240 μ at the apical end. The cells are longitudinally aligned, rectangular,



FIGS. 49–53. *Williamsonia bulbiformis* sp. nov. Fig. 49. Cuticle of the apical part of the interseminal scale (shield). LIL 2599. Fig. 50. Adaxial epidermis of a bract. LIL 2599. Fig. 51. Abaxial epidermis of a bract with stomata, hair bases and remains of hypodermis. LIL 2599. Figs. 52, 53. Stomata of abaxial epidermis of bract. LIL 2599.

square or trapezoidal with convex superficial walls which give rise to the papillose surface of the micropylar tube. The micropylar tube (Pl. 10, fig. 43) measures 300 μ in length and 222 μ, 175 μ and 225 μ respectively in basal, minimum and apical breadth.

Cuticle of bracts. The abaxial epidermis (Pl. 11, fig. 47 ; Text-fig. 51) of the bracts is different from the adaxial. The position of each of the cuticles was noted whilst they were still in the matrix, they were then removed and treated with Schulze's solution. In this way it was possible to show that only the abaxial epidermis possesses stomata.

The abaxial cuticle is thicker than the adaxial. It consists of cells aligned along the length of the bract, polygonal, elongated, rectangular or square and measuring 30 to 95 μ in length and 30 to 55 μ in width. Some of the rows of cells have longer cells than others.

The cuticle shows not only the outer walls of the cells but also the lateral walls, and in some parts the cuticle of the lower cell wall is preserved, where it replicates the outline of the cells of a hypodermis.

The stomata are orientated perpendicularly to the length of the bracts. They are like those of the interseminal scales, although the papillae of subsidiary cells are absent and the stomata are somewhat larger measuring 45 to 57 μ in length. In addition there are isolated hairs clustered in irregularly arranged transverse rows.

The adaxial epidermis (Pl. 11, fig. 46 ; Text-fig. 50) has cells of similar shape to those of the abaxial, although they are longer and the hypodermis is only weakly marked or entirely absent in some cuticles.

Discussion. The variations in size of *W. bulbiformis* are considered to be different stages of development of the ' flower ' because in all of them the form and character of the anatomical structure of the preserved cuticle of the megasporophylls and bracts is alike. In specimen BAPB no. 7999 where the megasporophylls are larger than in the other specimens, their size is considered to be the result of subsequent development after fertilization to maturity.

Williamsonia blandfordi Feistmantel (1877 : 29, pl. 1, figs. 4, 5 ; pl. 2, fig. 6 ; 1880 : 52, pl. 12, figs. 5–7) from the Jurassic of India, greatly resembles *W. bulbiformis* in shape and size, but differs in the larger number of narrower bracts and in the smaller diameter of the receptacle.

Williamsonia carruthersi Seward (1895 : 157, pls. 10, 11 ; text-fig. 8) from the Wealden of England differs from *W. bulbiformis* in the greater width of the bracts and the relatively smaller size of the conical receptacle.

The smaller specimens of *Williamsonia gigas* (Williamson 1870 ; Feistmantel 1877) resemble *W. bulbiformis*, but the receptacle of the former is relatively longer and narrower, whilst the interseminal scales are also longer and possess bracts with marginal hairs.

Williamsonia leckenbyi Nathorst (1911 : 21, pl. 6, figs. 1–10 ; 1909 : 14, pl. 3, figs. 1–10) has a much smaller receptacle and the length of the megasporophylls is relatively greater.

Comparisons with other species of *Williamsonia* show even greater differences.

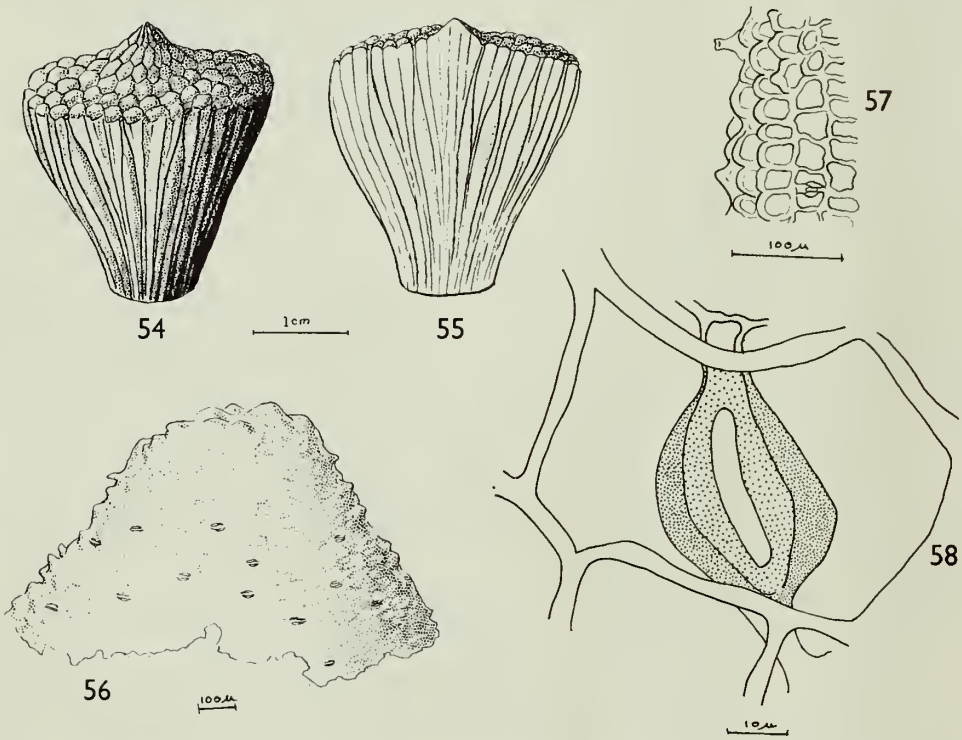
Williamsonia umbonata sp. nov.

(Pl. 12 ; Text-figs. 54–58)

DIAGNOSIS. Female 'flower' (or fructification) umbonate, approximately 3 cm. in diameter, bracts not preserved, interseminal scales polygonal in outline, 5–6 sided, 1·5 to 2 mm. in diameter, encircling megasporophylls. Megasporophylls 26 mm. long, 3·5 mm. in maximum width, fusiform, ending in tube 2 mm. in length. Cuticle of shields of interseminal scales with thick-walled cells arranged concentrically, superficial wall deeply convex or forming papillae, some of which constitute hair bases. Stomata syndetocheilic, concentrically arranged, with guard cells sunken and lateral wall well cutinized.

HOLOTYPE. LIL no. 2598.

OTHER MATERIAL. In addition to the holotype, BAPB no. 7997.



FIGS. 54–58. *Williamsonia umbonata* sp. nov. Fig. 54. Reconstruction of possible shape of specimen BAPB 7997. Fig. 55. Reconstructed section of specimen BAPB 7997. Fig. 56. Apical part of interseminal scale showing papillose surface and distribution of stomata. BAPB 7997. Fig. 57. Details of cuticle of interseminal scale showing the papillose cells and hairs. BAPB 7997. Fig. 58. Stoma of interseminal scale. BAPB 7997.

Description. The holotype (Pl. 12, fig. 49) is the impression of the upper part of a female cone (gynaecium), 3 cm. in visible diameter, on which the extreme end of each of the interseminal scales has left a concavity, usually of polygonal contour, 5–6 sided, with diameters from 1·5 to 2 mm. In a few cases there is a radial arrangement of the interseminal scales around what should correspond to the micropylar tube of a fertile megasporophyll. In the majority of the concavities the cuticle of the interseminal scales is preserved.

In the middle of the specimen there is a funnel-shaped hollow which being an external mould probably represents an umbonate apex of the fructification or ' flower ', in which the shields that form the apical part of the interseminal scales lengthen radially.

The size of the megasporophylls in specimen BAPB no. 7997 (Pl. 12, fig. 50 ; Text-figs. 54, 55) shows that it corresponds to a fructification, some megasporophylls of which have left their impression in the sediment and the greatest part having disappeared leaving a hollow. In the upper part of the hollow the cuticle of the apical shields of the megasporophylls still remains. This surface reproduces the original shape of the specimen, it is slightly hemispherical, 3 cm. in greatest diameter, with the central umbo equal to that in the holotype.

The sterile megasporophylls or interseminal scales are 26 mm. long, the fertile ones are fusiform and are 3·5 mm. wide tapering at the apex into a tube 2 mm. wide, corresponding to the micropylar tube. It is difficult to ascertain whether the organic remains of this specimen represent a complete fructification or only part of one. The position of the umbo in the centre and the equal size of both specimens suggest the approximate shape as in the reconstruction shown in Text-figs. 54 and 55.

Cuticle. Interseminal scales with the same characters were obtained from both specimens (Pl. 12, fig. 51). The interseminal scales, 1·5 to 2 mm. in diameter, are, in general, conical with rounded apex or more or less polygonal in outline. The cells are thick-walled and arranged concentrically they measure 40 to 60 μ in length by 20 to 40 μ in width. The superficial cell wall is convex or forms a papilla, some cells constitute the base of isolated hairs (Pl. 12, fig. 51 ; Text-fig. 57). The stomata (Pl. 12, fig. 52 ; Text-fig. 58) are syndetocheilic and are also arranged concentrically, the guard cells are sunken and the lateral wall heavily cutinized. The outline of the stomatal aperture is distinct. The stomata measure 50 to 60 μ in length and there are about 30 to 50 per sq. mm.

Discussion. It was thought at first that this specimen belonged to *W. bulbiformis*, the umbonate apex of the cone being merely a variation of that species. However, study of the cuticle from the shields showed that they were different. The number of stomata (30 to 50 per sq. mm.) was far greater than that observed in *W. bulbiformis* (2 to 6 per shield) and although the stomata are similar they are larger and are orientated with their longitudinal axes tangential to the contour. In addition the cutinization of the guard cells is heavier, as are the sides of the aperture, delineating the outline of the stomata more clearly. The cell walls in *W. umbonata* are thicker and more irregular, and the hairs and papillae more abundant than in *W. bulbiformis*.

The presence of the central umbo is a feature in common with *Williamsonia pyramidalis* Nathorst (1911 : 24, pl. 5, figs. 9, 10) from the Jurassic of Cloughton Wyke, Yorkshire with which it might be compared if only it were more complete.

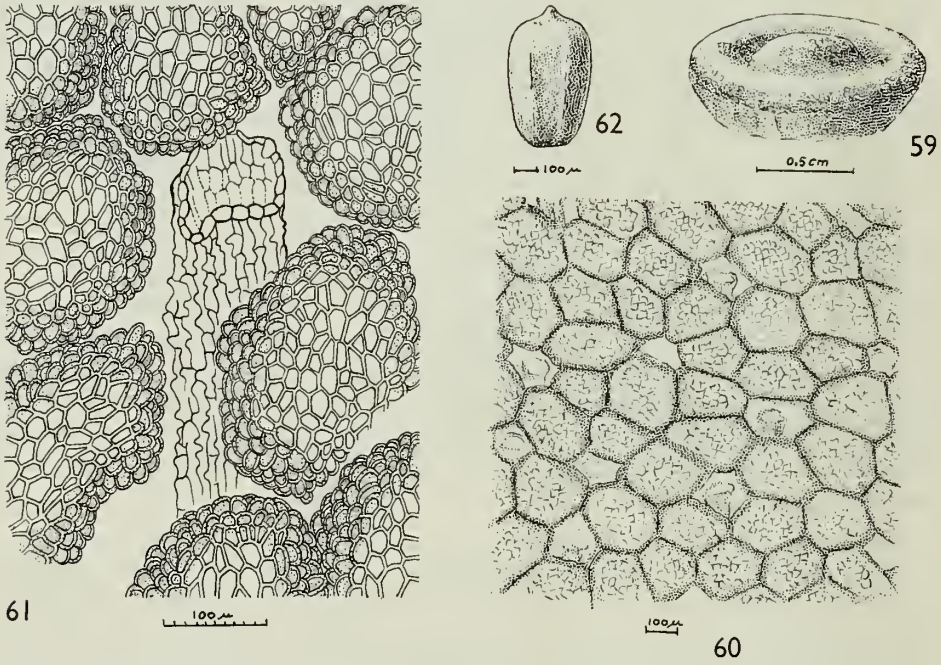
Nathorst considers that the umbo may be the base of attachment of the microsporophylls, which in his material appear to be outlined immediately above the female ' flower '. Without evidence of connexion, however, it is not possible to say whether it is a hermaphroditic ' flower ' or whether the position of the microsporophylls is a result of chance association.

Williamsonia sp.

(Pl. 13, figs. 53–56 ; Text-figs. 59–61)

The single specimen (BAPB 7982) of this undetermined species of *Williamsonia* consists of an external mould of a female cone (gynaecium) of a ' flower ' on the surface of which an almost complete cuticle was preserved.

Viewed from the upper side it is elliptical in shape with a central depression from which emerges a horizontally extended umbo (Text-fig. 59). The greatest diameter



Figs. 59–61. *Williamsonia* sp. Fig. 59. Reconstruction of specimen BAPB 7982. Fig. 60. General aspect of cuticle, showing arrangement of interseminal scales and micropyles. BAPB 7982. Fig. 61. Micropylar tube with papillose surface, surrounded by interseminal scales. BAPB 7982.

Fig. 62. Immature seed of *Williamsonia*. BAPB 7938

of the cone is 11 mm. and the smallest 7 mm. at the margins, it is 3·5 mm. high. There are no remains of bracts.

Impressed on the surface of the specimen are the polygonal outlines of the interseminal scales (Pl. 13, fig. 54), generally with 5–6 sides, and from 200–280 μ in maximum diameter. Five or six interseminal scales surround the micropyle. Towards the margins the interseminal scales enlarge and lengthen tangentially until they reach 5 or 6 times the size of the central scales.

Cuticle. The cuticle of the interseminal scales and of the micropyles has been perfectly preserved and remain united. The cell walls of the interseminal scales (Pl. 13, figs. 55, 56; Text-fig. 61) are straight, thick, bulging, from 15 to 38 μ in length and 10 to 20 μ in breadth. Stomata were not observed. The micropylar tube is a little more than 100 μ wide and shows rectangular papillose cells that are lengthened longitudinally.

Discussion. This specimen may be a young individual of one of the *Williamsonia* species already described, but the well formed structure of the interseminal scales and micropyle would indicate that it belongs to a small well developed 'flower' and for this reason and in the absence of diagnostic characters it seems preferable to leave it unnamed.

Immature seeds of ***Williamsonia***

(Pl. 13, fig. 57; Text-fig. 62)

On specimen BAPB no. 7938, associated with fragments of large interseminal scales, megasporophylls and parts of the axis of a 'flower' or fruit of *Williamsonia*, there is a series of small hollows many of which contain small carbonaceous bodies with a well-defined prismatic hexagonal or pentagonal shape.

These bodies are probably the remains of immature seeds of *Williamsonia*. The size of the previously recorded seeds of *Williamsonia* is from 4 to 6 mm. in length and 2·5 mm. in breadth (*W. bucklandi* and *W. gigas*) as compared with 0·5 to 0·7 mm. in length and 0·3 to 0·5 mm. in breadth of the specimens from Ticó.

In the specimens of *Williamsonia umbonata* and *W. bulbiformis* there are megasporophylls measuring up to 3 and 3·5 mm. in width respectively, which would indicate the presence of seeds of approximately the same size as those of other species.

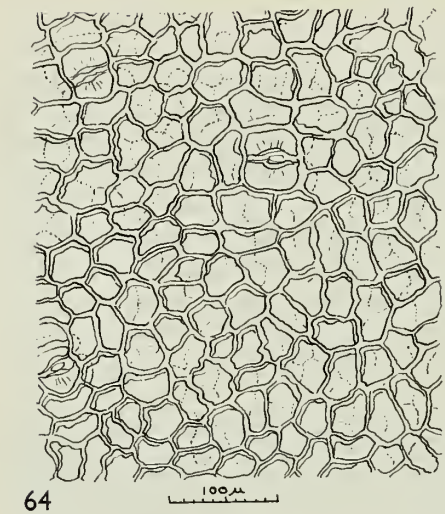
The shape of the seed is prismatic hexagonal or pentagonal, slightly narrowed towards the base with its ends rounded and in some specimens umbonate. Oxidization of the material only yields very small fragments of cuticle, possibly from the integument, without visible anatomical structure.

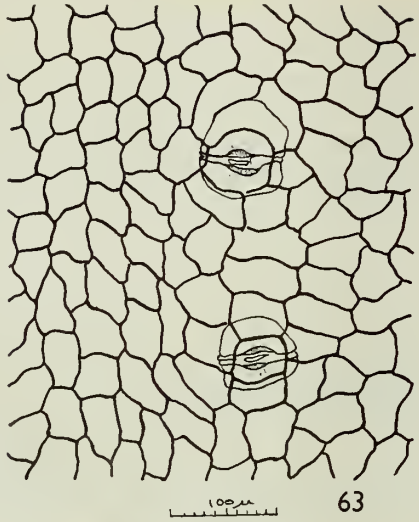
Genus ***CYCADOLEPIS*** Saporta

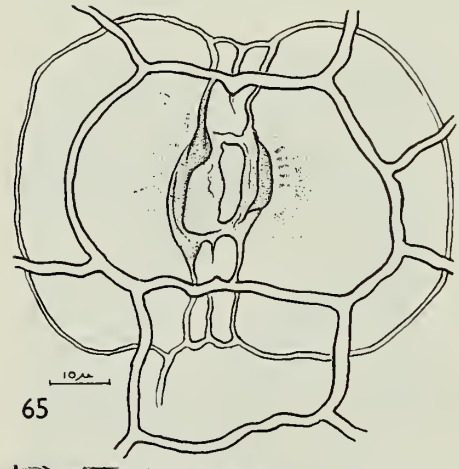
Cycadolepis coriacea sp. nov.

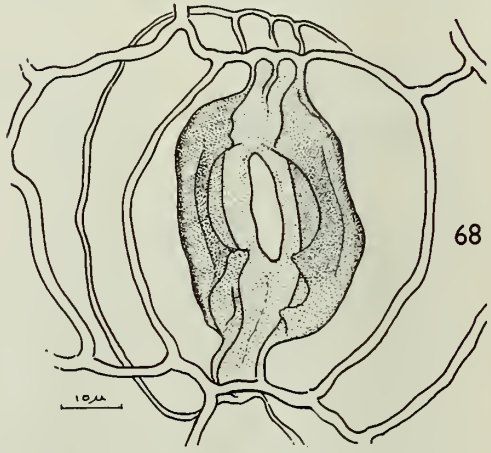
(Pl. 14, Pl. 15, figs. 63–65; Text-figs. 63–68)

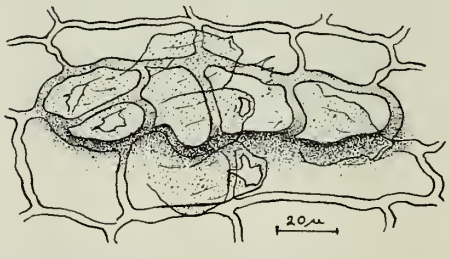
Diagnosis. Bract large, typically oblong or oval-lanceolate, length typically 63 mm. × 30 mm., abaxial side strongly convex, margins incurved and close to one











FIGS. 63–68. *Cycadolepis coriacea* sp. nov. Fig. 63. Adaxial epidermis with transverse stomata. B.M. (N.H.), V.45384. Fig. 64. Abaxial epidermis with thick-walled cells, sunken stomata and traces of hypodermal cells. B.M. (N.H.), V.45384. Fig. 65. Stoma from adaxial epidermis. B.M. (N.H.), V.45384. Fig. 66. Abaxial epidermis showing grouped hairs. BAPB 7924. Fig. 67. Details of grouped hairs. BAPB 7924. Fig. 68. Stoma of marginal region of bract. BAPB 7928.

another in the upper part ; base wide, line of insertion nearly straight. Veins nearly parallel in middle part, forking and anastomosing and curving outwards to the margins.

Abaxial cuticle thick, cells nearly isodiametric but elongated parallel with the veins in middle region and towards the margins, anticlinal walls very broad, nearly straight, surface wall flat.

Stomata scattered, orientated transversely to the veins ; whole apparatus somewhat sunken and poles of guard cells and outer margins of subsidiary cells overlapped by surrounding epidermal cells. Subsidiary cell surface showing transverse striae, no papillae present. Hypoderms present and slightly cutinized, composed of cells of about the same size as the epidermal cells. Trichome bases frequent, consisting of a transverse row of 3–6 cells (presumed to bear a flattened scale but free part not known) ; some one-celled trichome bases also present.

Adaxial cuticle less thick, distribution and character of stomata as on abaxial cuticle but number rather less. Cells elongated along the veins but isodiametric or transversely elongated between them. Cells rather larger than on abaxial side, anticlinal walls much thinner, straight or slightly sinuous. Trichome bases absent.

Holotype. LIL no. 2593.

Other material. In addition to the holotype, Brit. Mus. (Nat. Hist.) no. V.45384 ; BAPB nos. 7922, 7924 ; LPPB no. 5886.

Description. Five fairly similar specimens were studied. The holotype is the most complete, but some of the others show the base better ; this may be flat or distinctly incurved. The cuticle varies a good deal in different parts of the scale, thus there are no stomata near the base of the adaxial side and the stomata, orientated transversely to the veins, become parallel towards the margins. The cells are straighter walled in some parts than others.

Comparison. See *C. involuta.*

Cycadolepis involuta sp. nov.

(Pl. 16, ? Pl. 15, fig. 66 ; Text-figs. 69–76)

Diagnosis. Bract oblong but appearing more or less oval through incurving of margins ; typically 4·5 cm. × 2·5 cm. Veins longitudinal in middle part but curving out to meet margins at a right angle ; veins forking and anastomosing ; vein concentration near margin about 12 per cm.

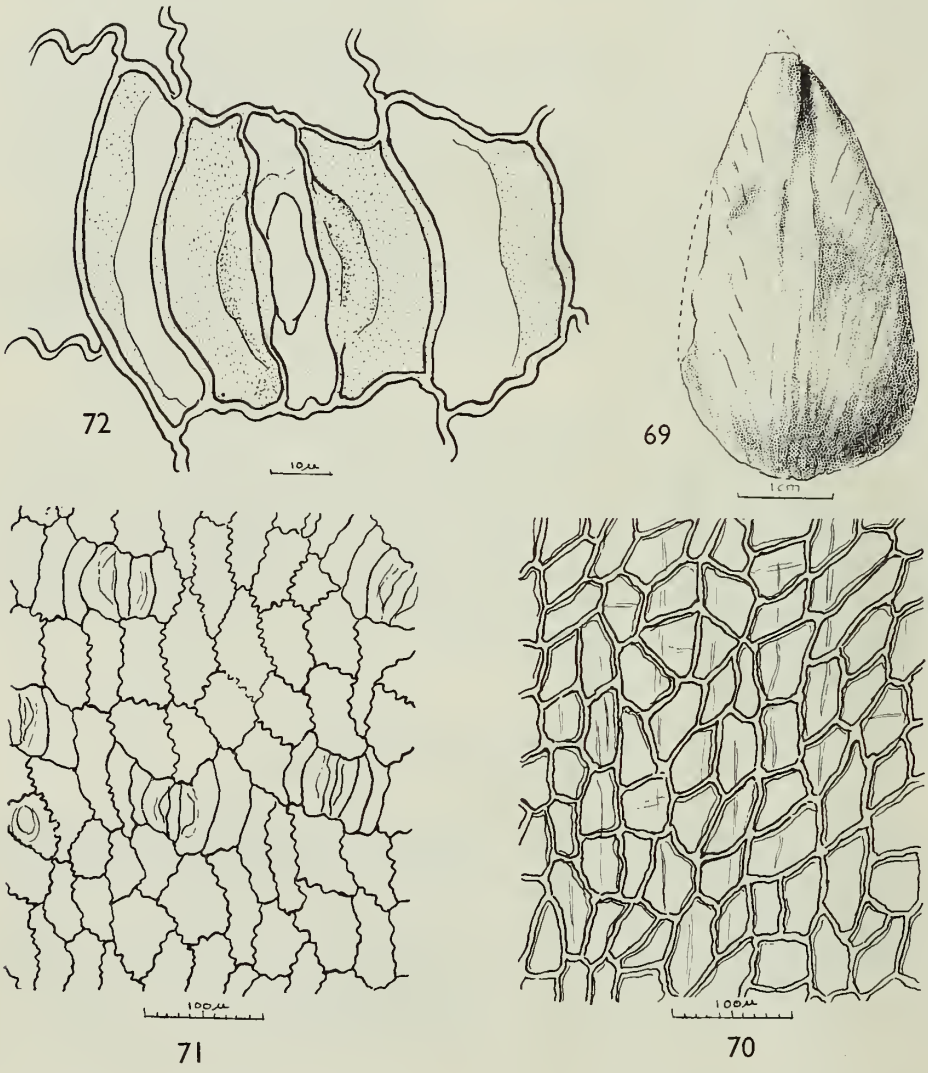
Abaxial cuticle showing polygonal or rectangular cells tending to form longitudinal files. Anticlinal walls distinctly and rather finely sinuous, cell surface often showing a small, hollow papilla. Unicellular trichome bases frequent in some regions. Stomata frequent, orientation variable or transverse to files of epidermal cells. Subsidiary cells rather small, surface thickened ; encircling cells often present opposite outer walls of subsidiary cells.

Adaxial cuticle thicker than abaxial. Cells tending to be rectangular and to form longitudinal files. Anticlinal walls thick, straight or nearly straight. Cell surface

flat. Stomata scarce but as on abaxial surface. Slightly cutinized, elongated hypodermal cells present.

HOLOTYPE. LIL 2594. Text-figs. 69–72.

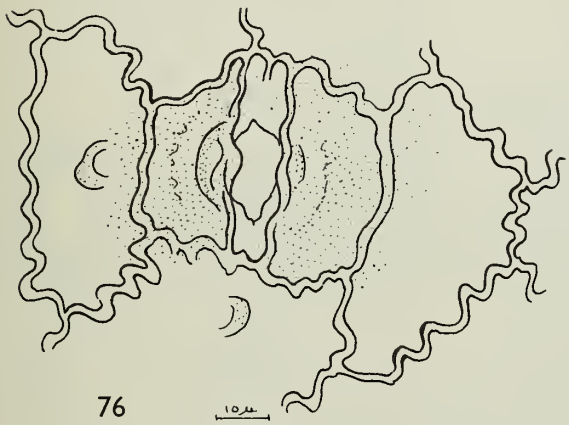
OTHER MATERIAL. In addition to the holotype, BAPB no. 7910.

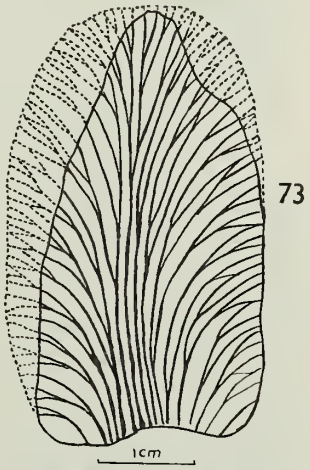


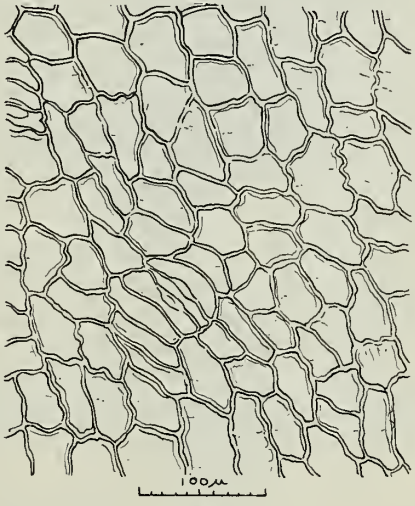
FIGS. 69–72. *Cycadolepis involuta* sp. nov. Fig. 69. Specimen with folded apex. Holotype, LIL 2594. Fig. 70. Adaxial epidermis, showing traces of hypodermal cells. LIL 2594. Fig. 71. Abaxial epidermis with stomata. LIL 2594. Fig. 72. Stoma of the same abaxial epidermis.

DESCRIPTION. Two satisfactory specimens are known and both are figured. In addition there is the specimen shown in Pl. 15, fig. 66 which is preserved in a sandy matrix and being without a cuticle is not determined with assurance.

COMPARISON. *C. involuta* looks like *C. rugosa* (Halle)—see Halle (1911) and Harris







FIGS. 73–76. *Cycadolepis involuta* sp. nov. Fig. 73. Reconstruction of specimen BAPB 7910. Fig. 74. Cuticle of the adaxial epidermis with few stomata. BAPB 7910. Fig. 75. Cuticle of the abaxial epidermis showing stomata, small papillae and trichome bases. BAPB 7910. Fig. 76. Stoma of the abaxial epidermis. BAPB 7910.

(1953), but its cuticle is very different. *C. rugosa* does not show sinuous walled cells with papillae. It also resembles *C. coriacea* and *C.* cf. *jenkinsiana* in the present flora in form though the epidermal cells readily distinguish it. It may be permissible to point out a certain resemblance between this scale and the pinna of a *Dictyozamites* (e.g. *D. crassinervis* or *D. latifolius*) both in the anastomosing veins and in the general character of the abaxial cuticle.

Cycadolepis cf. *jenkinsiana* (Tate) Seward

(Pl. 17 ; Text-figs. 77–81)

In present material bract very large, shape ovate-spatulate, apex rounded, lower part tapering. Length up to at least 14·5 cm., maximum width about 6 cm. Veins longitudinal in middle region but arching out to lateral margins which they meet at about 45°, forking and anastomosing. especially towards the margins Concentration of veins about 8 per cm. below, increasing to about 14 per cm. above. Longitudinal striae present between veins.

Cuticle of abaxial surface not known. Adaxial cuticle thin ; cells irregularly arranged, or in files parallel with the veins ; surface often showing a small median papilla ; anticlinal walls thin, sinuous. Stomata frequent variably orientated or transverse to the cell files, subsidiary cells fairly large, anticlinal walls smooth or slightly sinuous, surface flat. Trichome bases numerous consisting of a row or double row of rounded cells ; scattered unicellular trichome bases also occurring.

Specimen B.M.(N.H.) no. V.45387 showing the bases of two bracts gave good preparations of the adaxial cuticle only, the others gave less good preparations or none. The specimen in Pl. 17, fig. 72 is a bract folded down its middle. The anastomosing veins are clearly seen and also some of the striae. There are in addition a few other specimens preserved in sandstone which show the size and shape but no fine details.

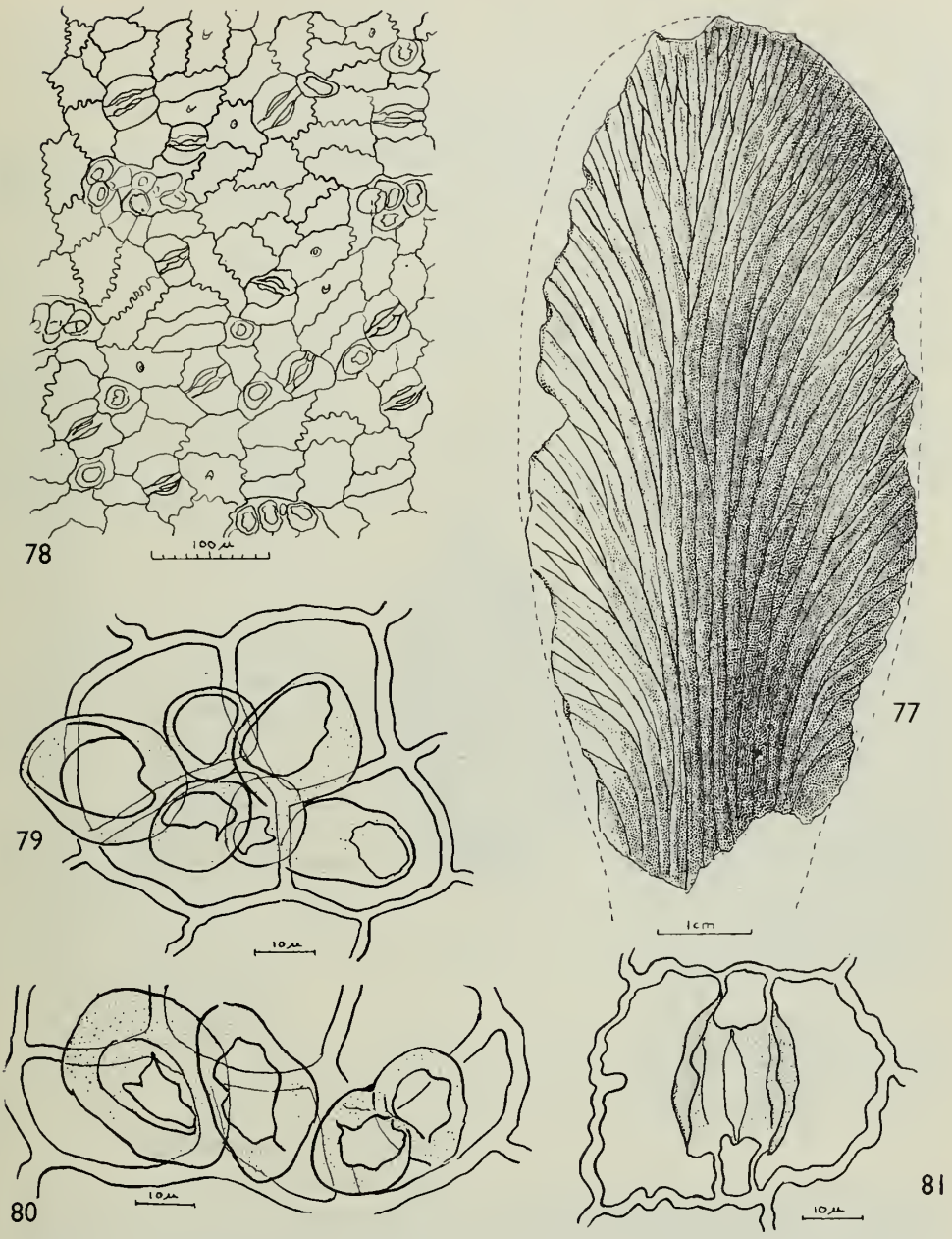
Discussion. The Ticó specimens resemble *C. jenkinsiana* (Tate) from the Wealden of Cape Province (Seward 1903) in form and venation; in particular Seward's pl. 4, fig. 6 is like the specimen shown here in Pl. 17, fig. 72.

Nothing is known about the cuticle of the African specimens so the comparison is incomplete. *C.* cf. *jenkinsiana* is also like large specimens of *C. rugosa* (see Halle 1911, Harris 1953) but in *C. rugosa* the adaxial cuticle has thick straight walls, sunken stomata and no bases of large trichomes.

Cycadolepis lanceolata sp. nov.

(Pl. 18 ; Text-figs. 82–86)

Diagnosis. Bract lanceolate, somewhat convex, up to 4 cm. × 1·3 cm., bearing marginal hairs up to 9 mm. long in middle part, hairs shorter towards apex and base of bract. Surface faintly marked by about ten longitudinal striations (veins?).

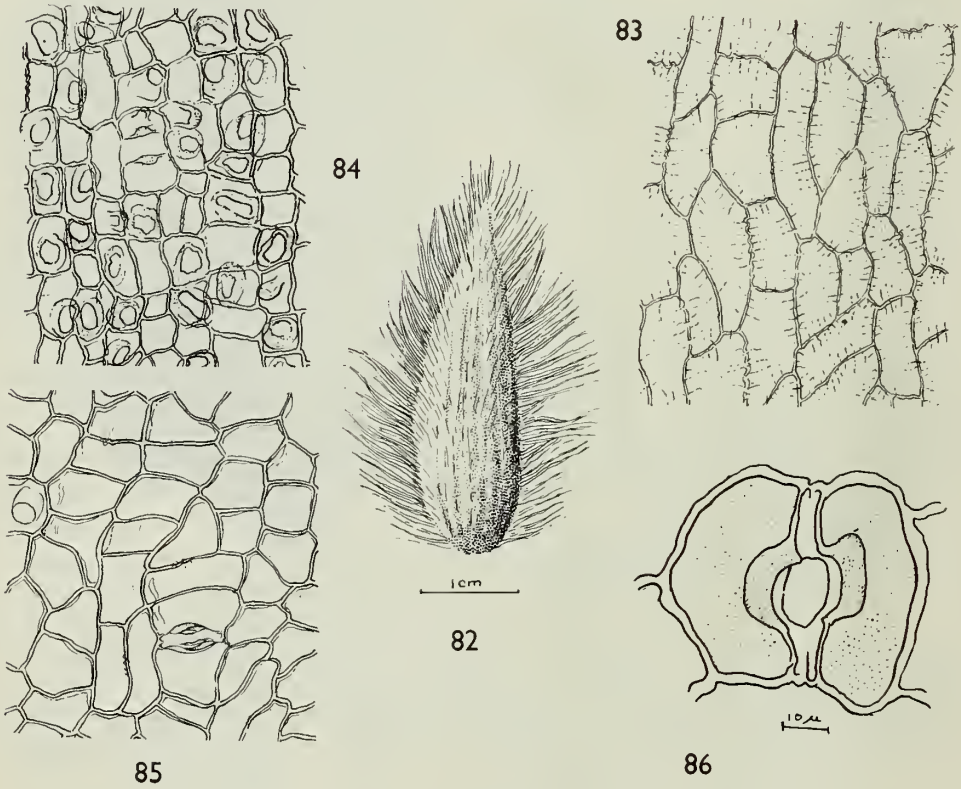


FIGS. 77–81. *Cycadolepis* cf. *jenkinsiana* (Tate) Seward. Fig. 77. Reconstruction of specimen LIL 2592. Fig. 78. Adaxial epidermis showing stomata, small papillae and isolated and grouped hairs. B.M. (N.H.), V.45387. Figs. 79, 80. Details of grouped hairs. B.M. (N.H.), V.45387. Fig. 81. Stoma of the adaxial epidermis. B.M. (N.H.), V.45387.

Abaxial cuticle with numerous stomata. Epidermal cells forming longitudinal files, anticlinal walls straight, fairly thick ; surface wall flat or bearing a large hollow papilla. Trichome bases very numerous and in some parts trichomes arising on every cell ; bases unicellular, rounded. Stomata scattered but transverse to the cell files, subsidiary cells fairly large sometimes bearing a papilla.

Adaxial cuticle similar but cells larger and sometimes showing faint ridges passing from anticlinal walls on to cell surface. Stomata infrequent, trichome bases rare, only exceptionally present.

Holotype. BAPB no. 7906.



Figs. 82–86. *Cycadolepis lanceolata* sp. nov. Fig. 82. General aspect of bract with marginal ramentum. BAPB 7906. Fig. 83. Adaxial epidermis with finely sinuate walls and with transverse wrinkles. BAPB 7906. Fig. 84. Abaxial epidermis with numerous hairs, some papillae and stomata. BAPB 7906. Fig. 85. Adaxial epidermis with straight-walled cells, few stomata and hairs. BAPB 7906. Fig. 86. Stoma from abaxial epidermis. BAPB 7906.

Other material. In addition to the holotype, Brit. Mus. (Nat. Hist.) nos. V.45373, V.45386 ; LPPB no. 5884.

Description. The two best specimens are the holotype and the one shown in Pl. 18, fig. 75. Two others are in a sandy rock and have no cuticles preserved.

Comparison. A good many hairy kinds of *Cycadolepis* are known. The following are particularly similar.

C. eriphous Harris (1953) from the Middle Jurassic of Yorkshire is larger and has no stomata on the abaxial cuticle.

C. mexicana Wieland (1914) from the Liassic of Mexico is larger and with longer hairs.

C. johanssoni Harris from the basal Liassic of Greenland and of Sweden (Johansson 1922) as *C. rugosa* is often longer, the surface is rugose and the stomata are orientated longitudinally.

It is interesting that *Williamsonia virginiensis* Fontaine (1889) from the Lower Cretaceous of Potomac shows rather similar bracts. *C. oblonga* described in this work has fewer hairs and no papillae on the adaxial surface. The adaxial cells are longer and the walls thinner and never at all sinuous.

Cycadolepis oblonga sp. nov.

(Pl. 19 ; Text-figs. 87–91)

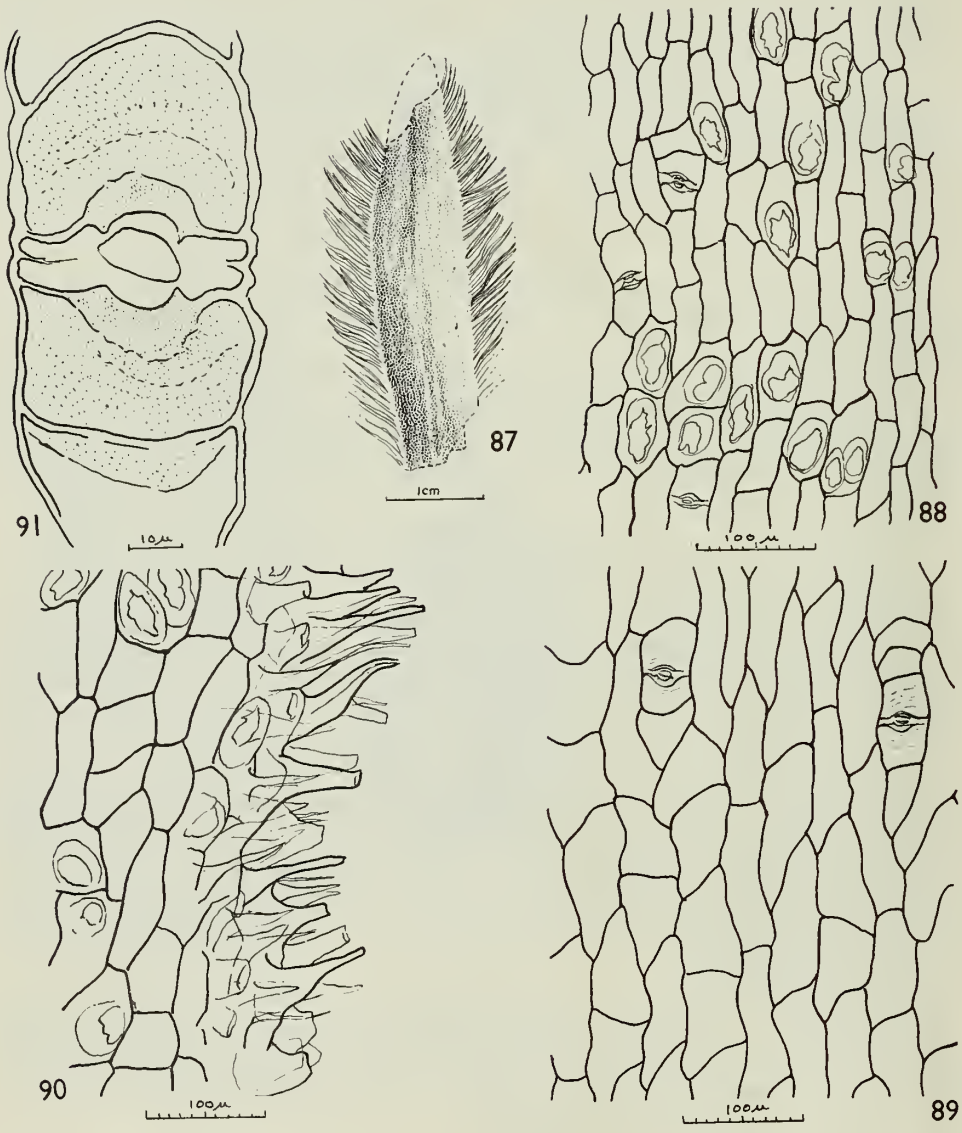
Diagnosis. Bract oblong lanceolate, typically about 4 cm. long × 0·8 cm. wide, width uniform in the lower two-thirds but tapering to the apex. Surface only slightly convex, marked with faint longitudinal grooves. Margins hairy, marginal hairs about 7 mm. long in the middle region but becoming shorter both towards the apex and base of the bract.

Abaxial cuticle showing somewhat elongated cells in longitudinal files, anticlinal walls straight or curved, not sinuous, surface flat. Many cells bearing unicellular trichome bases, and occasional groups of about five side by side, representing broad trichomes or a row of unicellular ones. Stomata frequent, transverse to cell files ; subsidiary cells fairly large, not papillate. Occasionally with lateral encircling cells. Adaxial cuticle showing considerably larger cells of same general shape ; stomata rare ; trichomes absent.

Holotype. BAPB no. 7907. The only specimen.

Description. *C. oblonga* is represented by the holotype alone, a well preserved specimen lacking its extremities ; its original length may have been over 4 cm. It is very like *C. lanceolata* in form and cuticle but it is considered that the differences given above are sufficient to distinguish it.

Comparison Several species are of similar shape and size. *C. spheniscus* Harris (1953) differs in lacking marginal hairs. *C. johanssoni* Harris (1953) from the Greenland Lower Liassic differs in its rugose surface, shorter cells and longitudinal stomata. *C. hirta* Saporta (1875) from the French Upper Jurassic is of unknown structure ; it may be relatively longer.



FIGS. 87–91. *Cycadolepis oblonga* sp. nov. Fig. 87. General aspect of bract with marginal ramentum. BAPB 7907. Fig. 88. Abaxial epidermis with trichome bases, cells in longitudinal rows and transverse stomata. BAPB 7907. Fig. 89. Adaxial epidermis with stomata. BAPB 7907. Fig. 90. Details of marginal ramentum. BAPB 7907. Fig. 91. Stoma of adaxial epidermis. BAPB 7907.

III PROBABLE AGE OF THE FLORA

The flora of the Ticó area of Santa Cruz Province, Argentina is rich and well preserved, but many of its genera are new and so are nearly all the species. Three species however have been identified with those of other floras and the generic identification of others throws some light on the age. The three are *Athrotaxis ungeri*, *Ptilophyllum hislopi*, *Cycadolepis jenkinsiana*; the determination of the last two being rather insecure.

Athrotaxis ungeri (Halle) described by Archangelsky (1963) from Ticó has also been recorded from Rio de los Fósiles in the area of Lake San Martin, Santa Cruz Province, which Halle (1913) assigns to the Lower Cretaceous because of its association with strata bearing marine fossils. The species is also represented in the valley of Rio Cardiel overlying beds containing *Crioceras deeckei* from the Barremian (Piatnizky 1938) together with *Nathorstia alata* Halle which also occurs in Rio de los Fósiles. Frenguelli (1949) records *Athrotaxis ungeri* in Canadon Asfalto, Chubut, together with other plants which he assigns to the Bajocian or base of the Lower Calovian and correlates with the Jabalpur Series considered by him to be Dogger, although many authors place this series in the Lower Cretaceous or Upper Jurassic.

Ptilophyllum hislopi is a determination without the advantage of knowledge of the cuticle. In India it occurs in the Rajmahal flora the age of which is not precisely known but it must be between Lower and Upper Jurassic. It also occurs in the (roughly) Middle Jurassic of Graham Land and the Middle Jurassic of Neuquen in Argentina and is recorded from the Lower Cretaceous of India.

C. cf. *jenkinsiana*, is identified (though again without the evidence from the cuticle) with the original specimens from the Wealden of S. Africa.

Of genera which give some rough indications of age we have :

Brachyphyllum with four species. Conifers with this sort of foliage are doubtless of more than one family, but even so it is true that the number of species increases from the Rhaetic onwards and is at a maximum around the Upper Jurassic and Lower Cretaceous.

Dictyozamites according to Jacob (1951) is characteristic of the Middle Jurassic, but it must be remembered that some of the floras in which it occurs are imperfectly dated. It certainly has several species in the Upper Jurassic of Japan, but the only Cretaceous record known to the writer is a doubtful one from S. Africa.

Otozamites which is rare in the Rhaetic increases through the Lower Jurassic to a maximum in the Middle Jurassic. It is still very common in the Upper Jurassic but less so in the Lower Cretaceous.

Zamites is scarcely known with any security before the Middle Jurassic. It extends into the Lower Cretaceous.

Pterophyllum is at a maximum in the Upper Triassic, but it occurs in diminishing numbers up to the Lower Cretaceous. In the Ticó flora it is represented by a single imperfectly known species.

The general inference on the present rather few and sometimes insecure determinations of species and the reliable determinations of genera—which however, have

longer ranges—is that the Ticó flora is younger than Middle Jurassic, but where it lies in the range of Upper Jurassic and Lower Cretaceous is best left until we have more and clearer evidence.

IV ACKNOWLEDGMENTS

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PLATE 1

Otozamites parviauriculata sp. nov.

FIG. 1. Fragment of frond. Holotype, LIL 2600. ×1.
FIG. 2. Fragment of frond with more elongated pinnae. BAPB 7961. ×1.
FIG. 3. Specimen BAPB 7963. ×1.

Otozamites grandis sp. nov.

FIG. 4. Fragment of frond with imbricate pinnae. Holotype, LIL 2590. ×1.
FIG. 5. Specimen showing details of insertion of pinnae. BAPB 7968. ×2.
FIG. 6. Specimen with large pinnae. BAPB 7964. × 1.

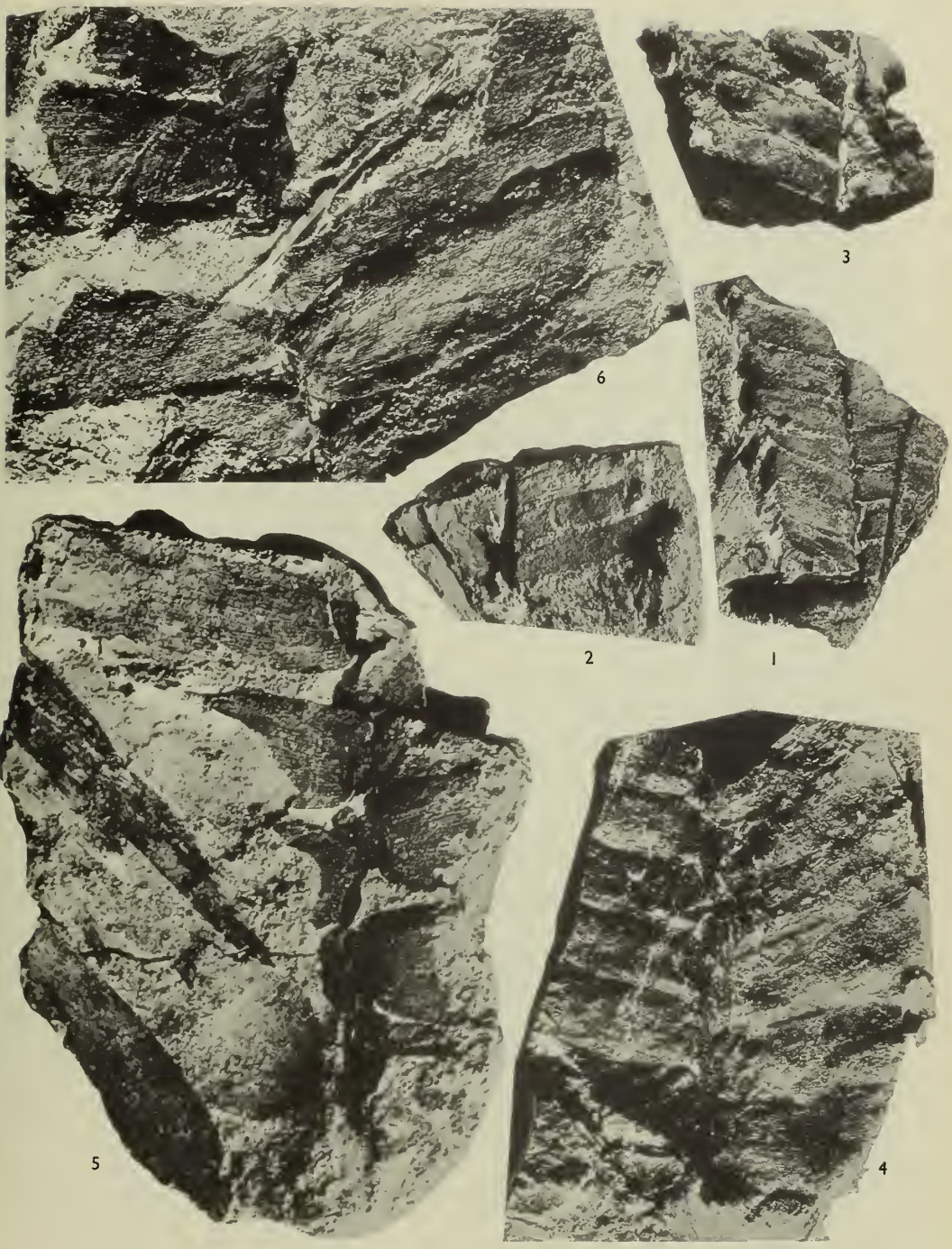
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PLATE 2

Otozamites parviauriculata sp. nov.

FIG. 7. Cuticle of lower epidermis with stomata aligned in spaces between nerves; hairs and abundant papillae. Holotype, LIL 2600. ×200.

FIG. 8. Stomata sunken in bottom of outer stomatal chamber with its aperture encircled by a crown of papillose cells. Holotype, LIL 2600. ×1000.

Otozamites grandis sp. nov.

FIG. 9. Cuticle of upper (left) and lower epidermis. B.M. (N.H.), no. V.45370, ×200.

FIG. 10. Stomata and papillae. BAPB 7968. ×1000.

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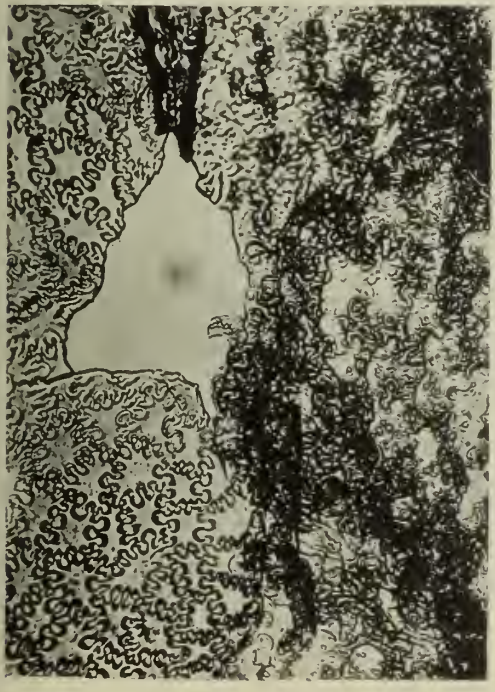

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PLATE 3

Dictyozamites minusculus sp. nov.

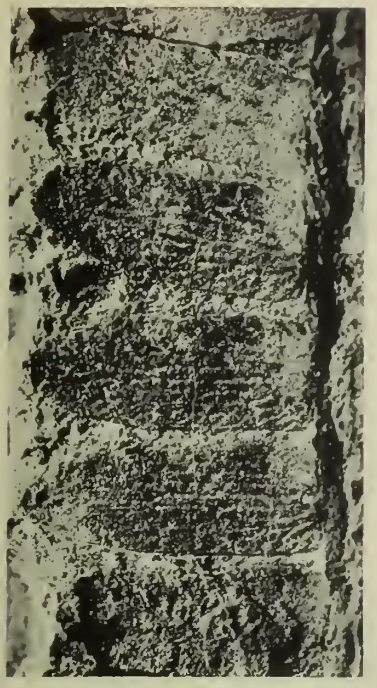
FIG. 11. Enlarged fragment of frond to show details of insertion of pinnae, and nervation. BAPB 7976. ×5.

FIG. 12. Fragment of frond with pinnae preserved on one side. Holotype, LIL 2591. ×2.

FIG. 13. Fragment of frond with alternate pinnae. B.M. (N.H.), no. V.45374. ×2.

FIG. 14. Cuticle of lower epidermis with numerous trichome bases and papillae. BAPB 7971. ×200.

FIG. 15. Stoma with papillae projected over the aperture, trichome bases and papillae. BAPB 7971. ×1000.



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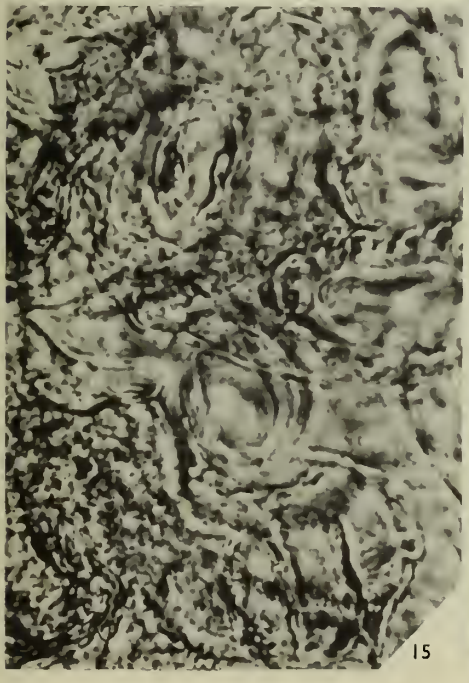

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PLATE 4

Dictyozamites crassinervis sp. nov.

FIG. 16. Part of frond with three fragments of pinnae. Holotype, BAPB 7979. ×1.

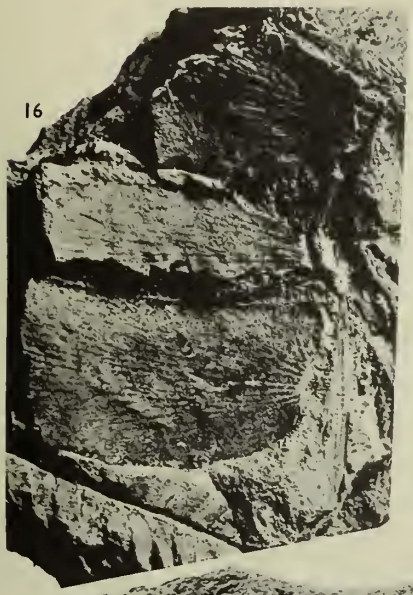
Dictyozamites latifolius sp. nov.

FIG. 17. Fragment of frond preserved in a coarse sandstone, with alternate and imbricate pinnae. B.M. (N.H.), no. V.45376. ×1.

FIG. 18. Rubber mould of a pinna showing details of the nerves. BAPB 7917. ×1·5.

FIG. 19. Impression of pinnae on sandstone. BAPB 7916. ×1.

FIG. 20. Impression of pinnae in a tufaceous clay, showing the anastomosing nerves. Holotype, BAPB 7995. ×1.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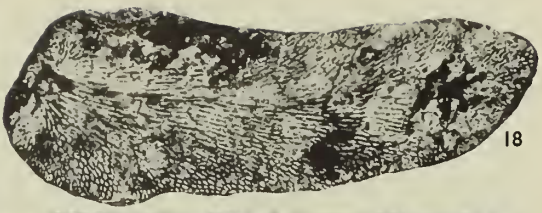
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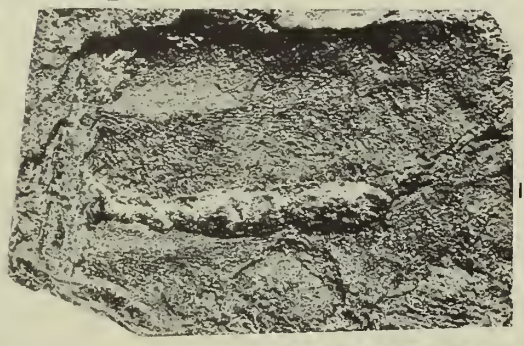
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PLATE 5

Dictyozamites crassinervis sp. nov.

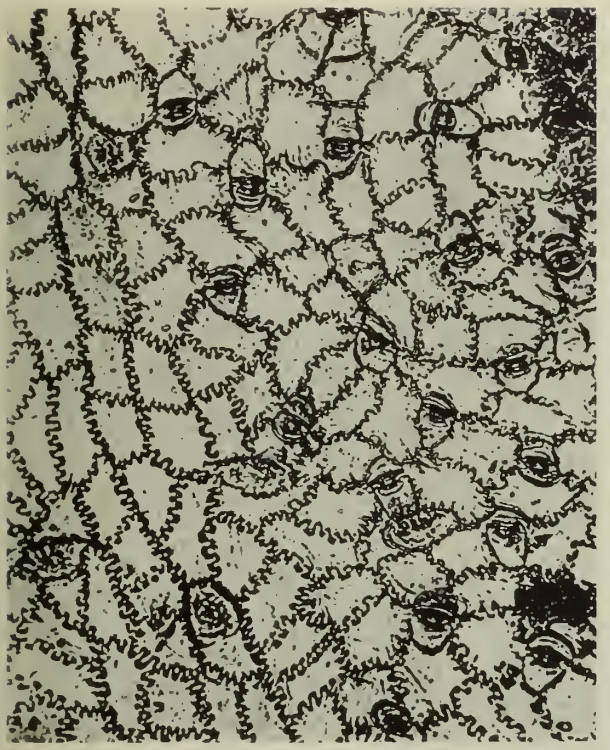
FIG. 21. Cuticle of lower epidermis with longitudinally elongated cells on the nerves (left) and stomata transversely arranged between the nerves. Holotype, BAPB 7979. ×200.

FIG. 22. Stomata from the same specimen, with heavily cutinized subsidiary and guard cells. ×1000.

Dictyozamites latifolius sp. nov.

FIG. 23. Cuticle of lower epidermis with cells elongated longitudinally on the nerves (left). Isodiametric cells and stomata transversely arranged between the nerves. LIL 2597. ×200.

FIG. 24. Stomata encircled by papillae. LIL 2597. ×1000.



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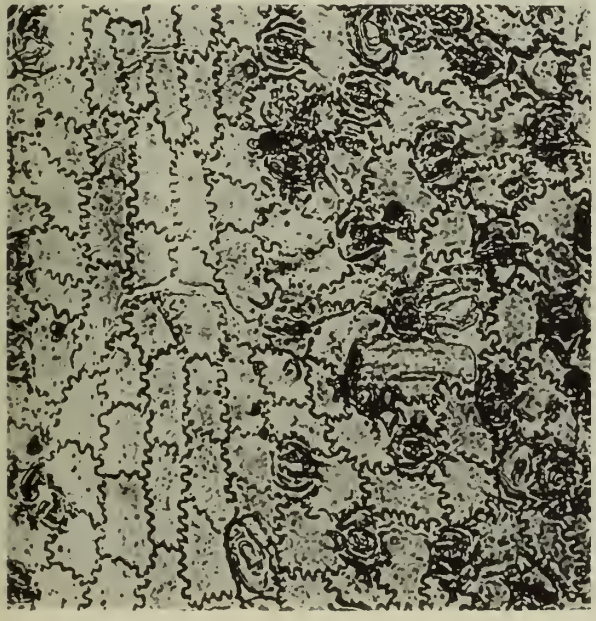

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PLATE 6

Ptilophyllum longipinnatum sp. nov.

FIG. 25. The most complete frond. BAPB 7940. ×1.
FIG. 26. Apical part of a frond. LPPB 5898. ×1.
FIG. 27. Cuticle of lower and upper epidermis. BAPB 7951. ×65.
FIG. 28. Stomata with papillae on the stomatal aperture. BAPB 7956. ×1000.

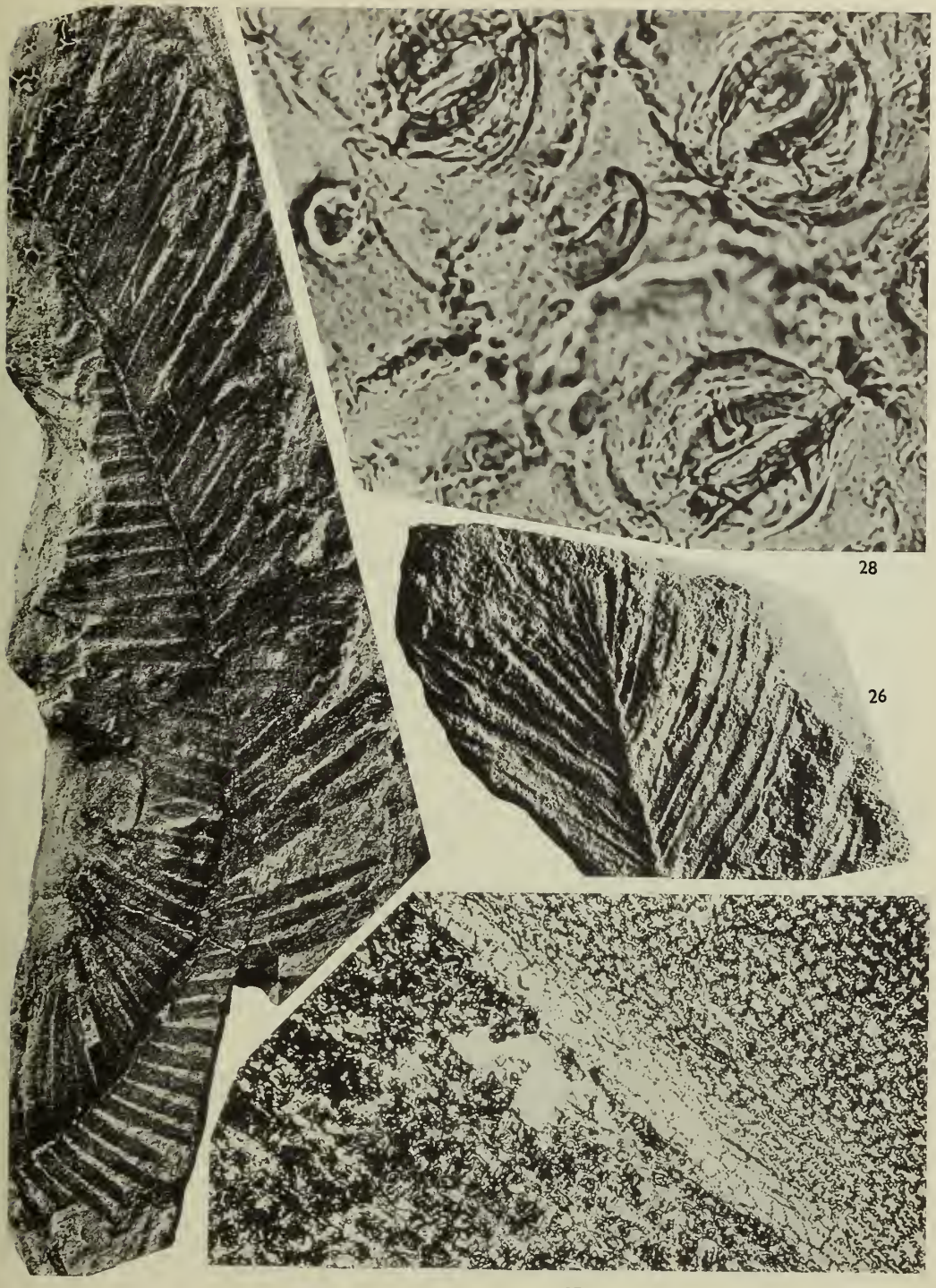

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PLATE 7

Ptilophyllum hislopi (Oldham) Seward

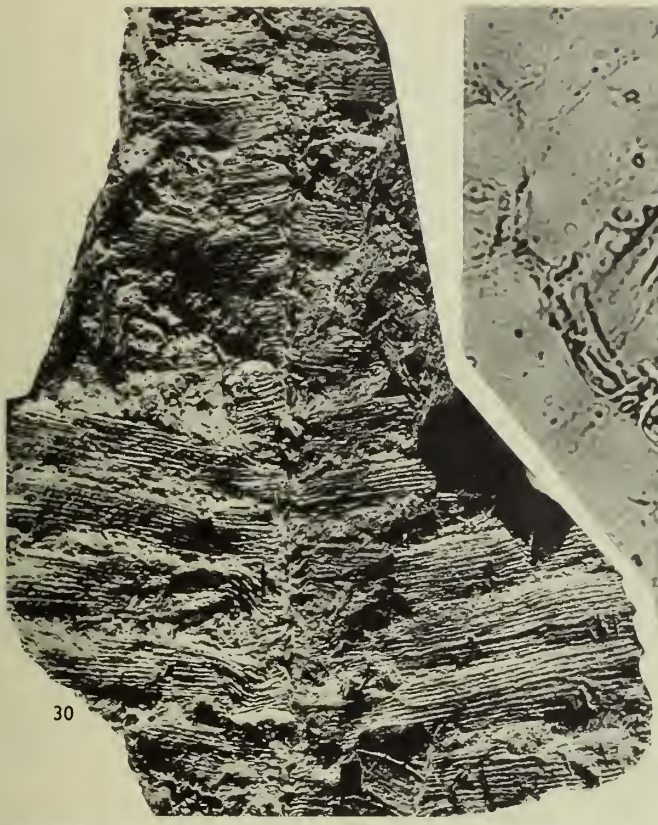
FIG. 29. Impression of a fragment of frond. BAPB 7938. ×1.

Pterophyllum sp.

FIG. 30. Fragment of frond with linear pinnae. BAPB 7959. ×2.

FIG. 31. Cuticle of lower epidermis showing the transversely orientated stomata in the spaces between the nerves, and cells with thickened surface. BAPB 7959. ×200.

FIG. 32. Stoma showing the thickening of the subsidiary cells and small papillae on both sides of the aperture. BAPB 7959. ×1000.



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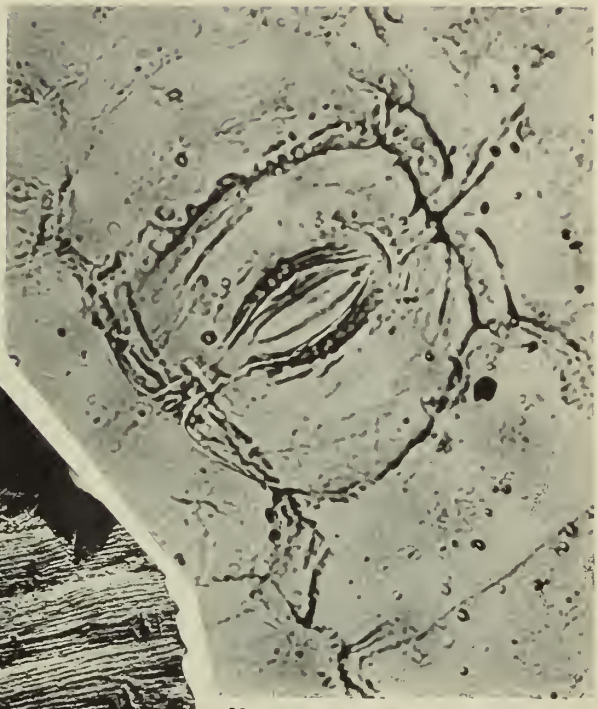

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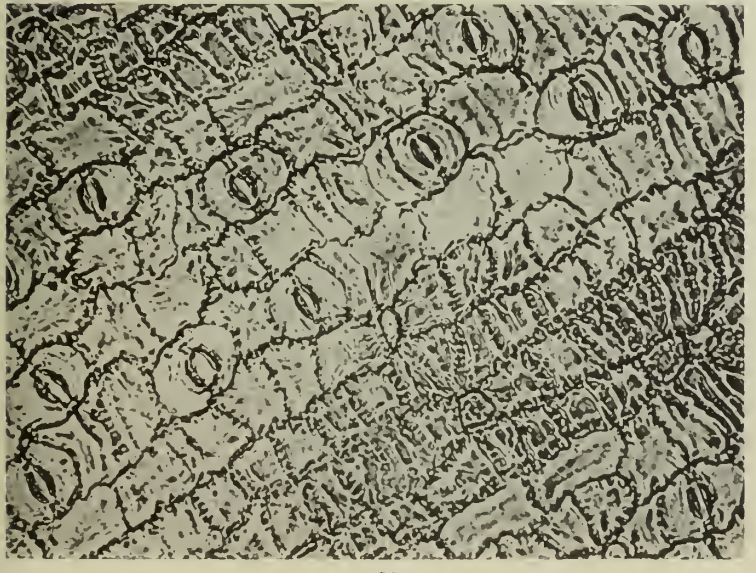

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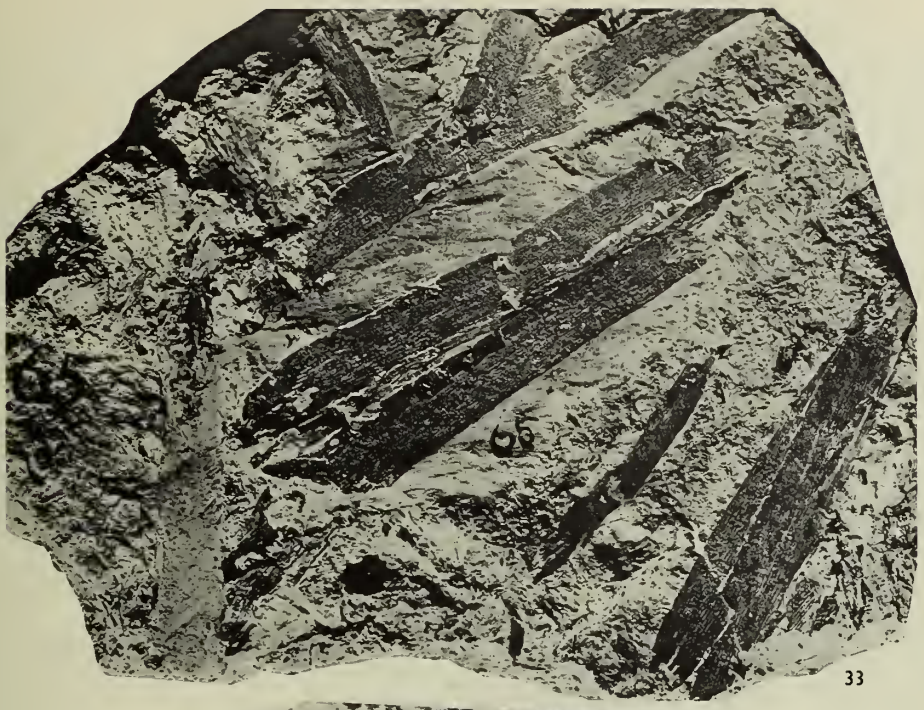
PLATE 8

Zamites decurrens sp. nov.

FIG. 33. The largest specimen. Holotype, LIL 2596. ×1.
FIG. 34. Specimen with proportionally longer pinnae. BAPB 7928. ×1.



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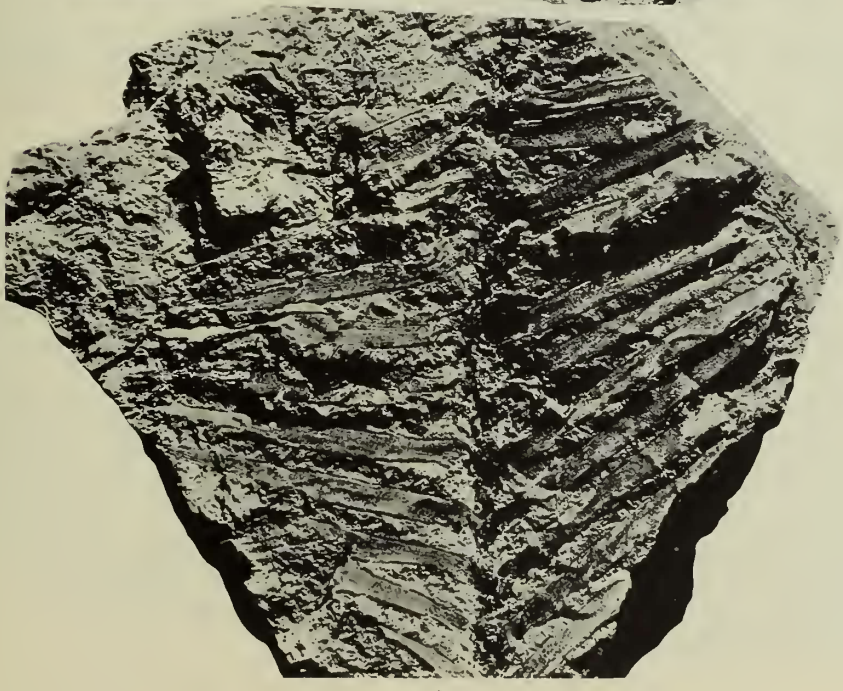

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PLATE 9

Zamites decurrens sp. nov.

FIG. 35. Fragment of a small frond. BAPB 7927. ×2.

FIG. 36. Cuticle of lower epidermis showing globose cells on the nerves ; the stomata, hairs and papillae are on the areas between the nerves. A fragment of the upper epidermis can be seen above. BAPB 7927. ×200.

FIG. 37. Fragment of frond showing the pinnae decurrent to the rachis. B.M. (N.H.), no V.45379. ×1.

FIG. 38. Stomata of lower epidermis. BAPB 7927. ×1000.

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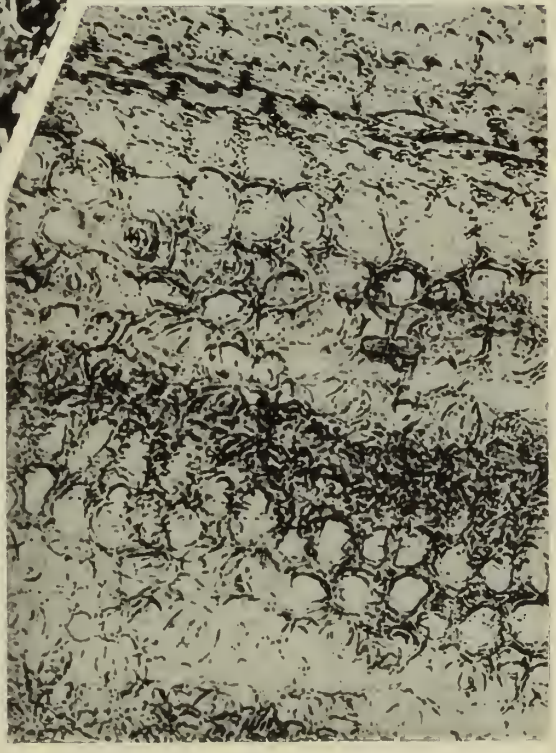

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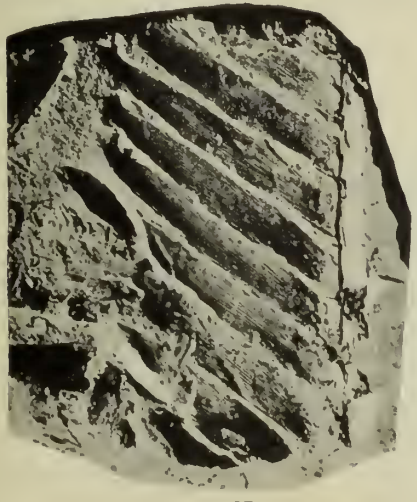

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PLATE 10

Williamsonia bulbiformis sp. nov.

FIG. 39. Basal view of ' flower ' showing in the centre the hollow left by the receptacle surrounded by interseminal scales and bracts. BAPB 7998. ×1.

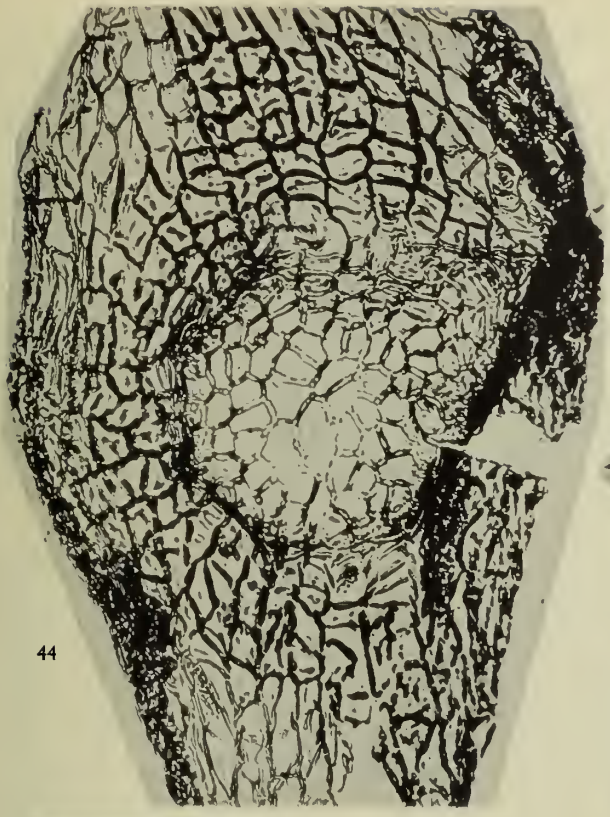
FIG. 40. Same ' flower ' in lateral view. ×1.

FIG. 41. Specimen representing half of a ' flower ' with the hollow of the receptacle, interseminal scales and bracts. B.M. (N.H.), no. V.45381. ×2·5.

FIG. 42. Lateral view of a section of a fertile ' flower ' (fructification). Above, the external mould, below, the casts of fertile megasporophylls and interseminal scales. BAPB 7999. ×2.

FIG. 43. Micropylar tube showing the papillose surface. BAPB 7999. ×200.

FIG. 44. Cuticle of apical portion of interseminal scale (shield) showing central dome and sparse stomata. BAPB 799. ×200.



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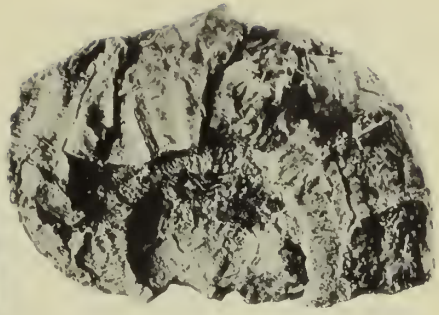

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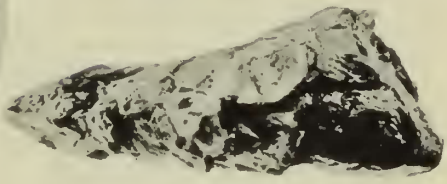

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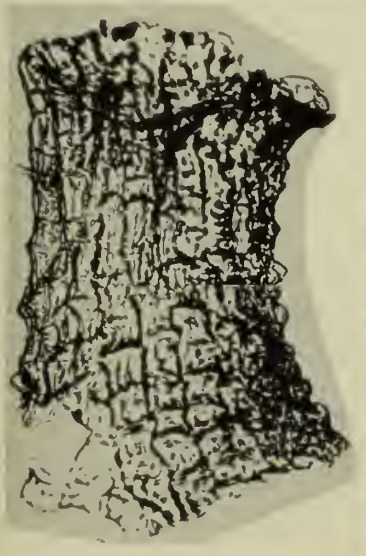

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PLATE 11

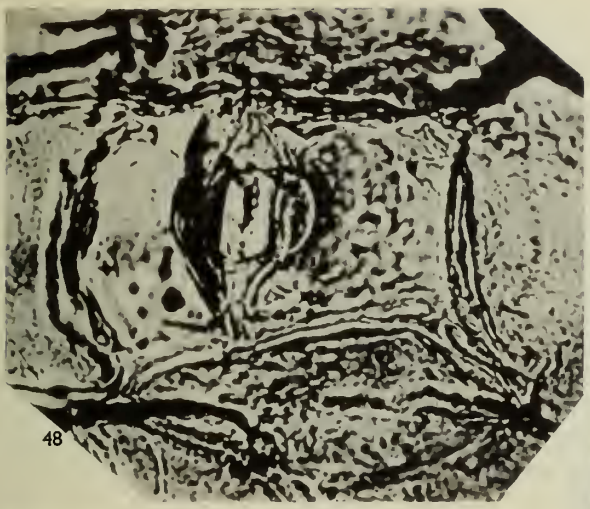
Williamsonia bulbiformis sp. nov.

FIG. 45. Basal part of ' flower ' showing central concave impression of receptacle, surrounded by ring of fertile and sterile megasporophylls and bracts that enclosed the ' flower '. Holotype, LIL 2599. ×2.

FIG. 46. Cuticle of adaxial epidermis of bract. LIL 2599. ×200.

FIG. 47. Cuticle of abaxial epidermis of the same bract showing stomata, some hairs and remains of hypodermal cells. ×200.

FIG. 48. Stoma of abaxial epidermis of bract. LIL 2599. ×1000.



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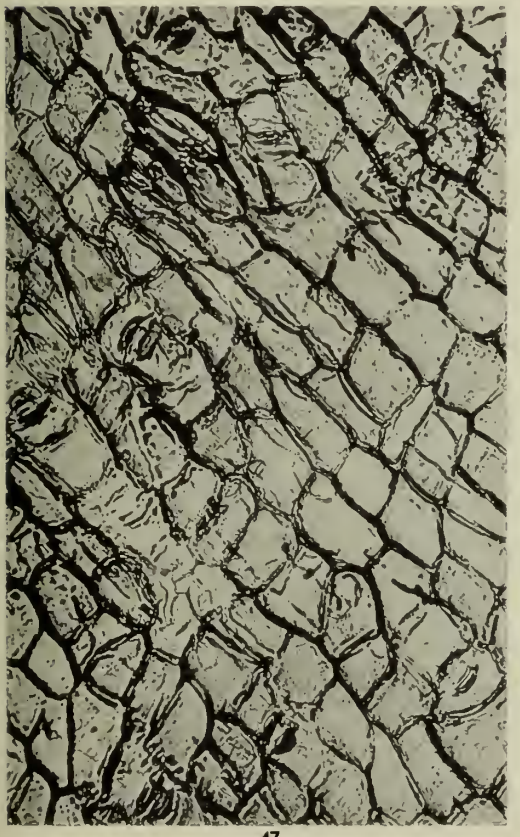

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PLATE 12

Williamsonia umbonata sp. nov.

FIG. 49. Impression of upper part of female cone with apical part of megasporophylls shown in inverse relief, and a central funnel-shaped hollow corresponding to an umbonate apex. Holotype, LIL 2598. ×2.

FIG. 50. Lateral view of specimen BAPB 7997, showing, above, the impression of the upper surface with a funnel-shaped hollow and remains of cuticle, and, in the middle, the impression and casts of megasporophylls. ×2.

FIG. 51. Cuticle of marginal part of shield of an interseminal scale showing hairs and papillose cells. BAPB 7997. ×200.

FIG. 52. Stoma of an interseminal scale. BAPB 7997. ×1000.

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PLATE 13

Williamsonia sp.

FIG. 53. External mould of female cone (gynaecium) of a ' flower '. BAPB 7982. ×4.
FIG. 54. Same specimen more enlarged showing impressions of interseminal scales. ×7.
FIG. 55. Cuticle of margin of ' flower ' with micropyles, surrounded by interseminal scales. The scales of the margin (above) are larger and tangentially elongated. BAPB 7982. ×80.
FIG. 56. Micropylar tube with papillose cells, surrounded by interseminal scales. BAPB 7982. ×200.

Immature seeds of *Williamsonia*

FIG. 57. Seeds found among fragments of large megasporophylls of *Williamsonia*. BAPB 7938. ×35.

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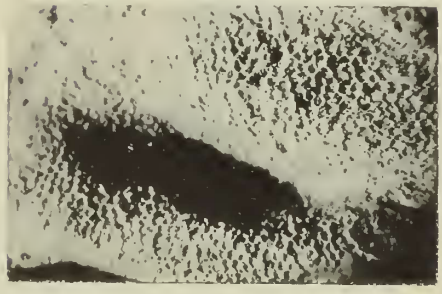

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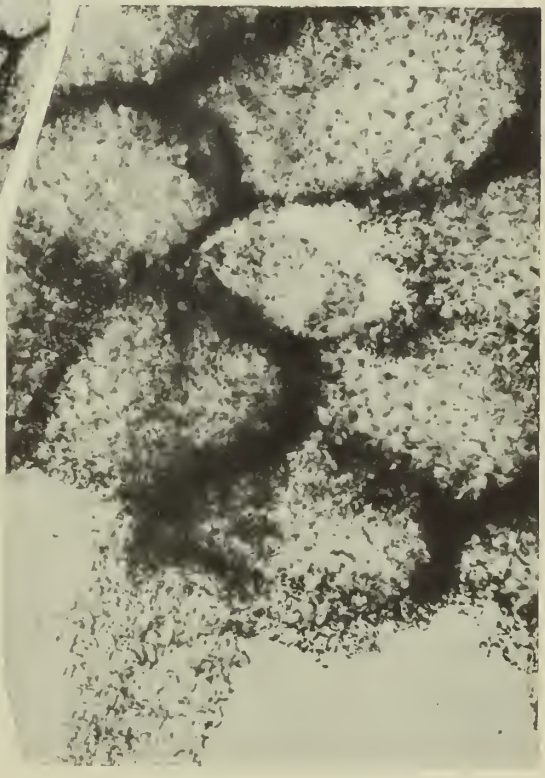

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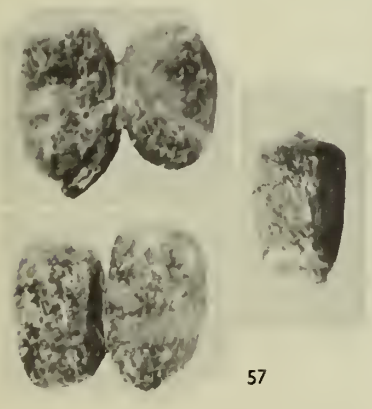

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PLATE 14

Cycadolepis coriacea sp. nov.

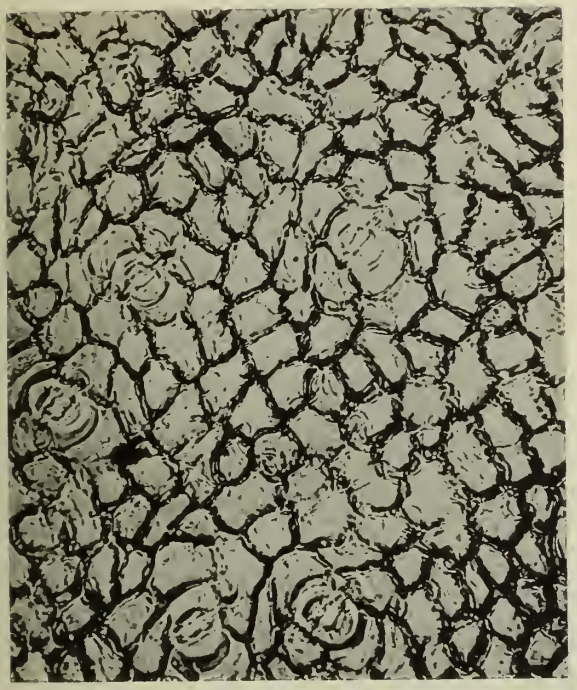
FIG. 58. Basal part of a bract. B.M. (N.H.), no. V.45384. ×2.

FIG. 59. Same specimen. ×1.

FIG. 60. Cuticle of abaxial epidermis with thick-walled cells and sunken stomata. B.M. (N.H.), no. V.45384. ×200.

FIG. 61. Cuticle of adaxial epidermis. B.M. (N.H.), no. V.45384. ×200.

FIG. 62. Stoma of abaxial epidermis. B.M. (N.H.), no. V.45384. ×1000.



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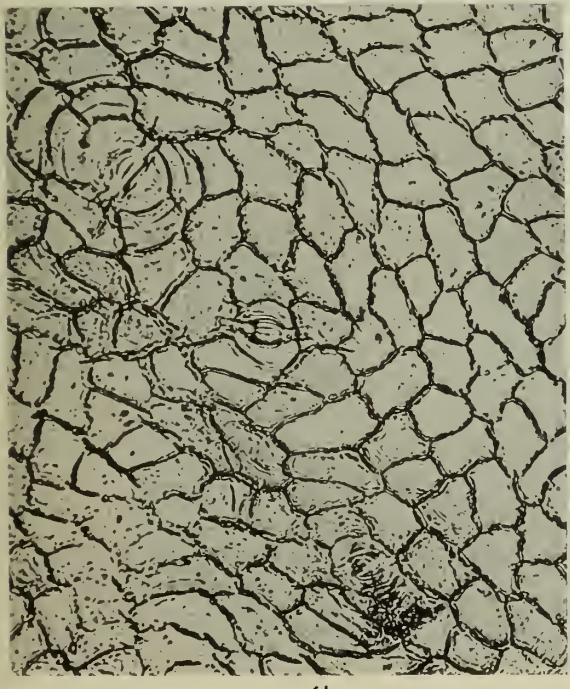

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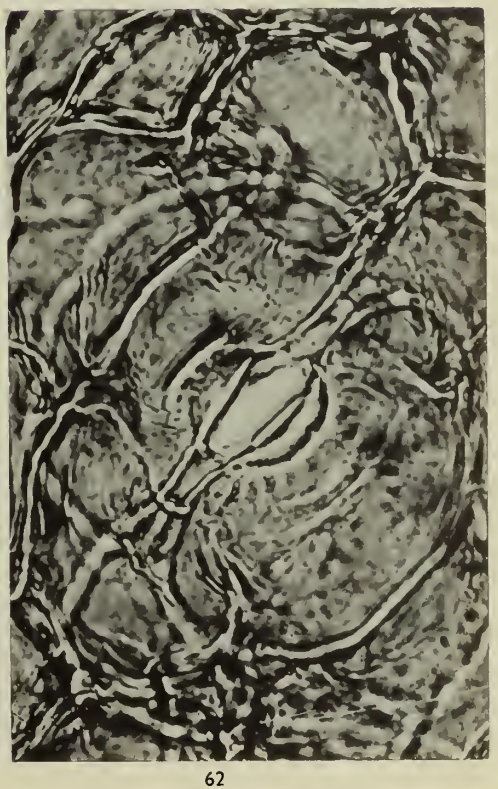

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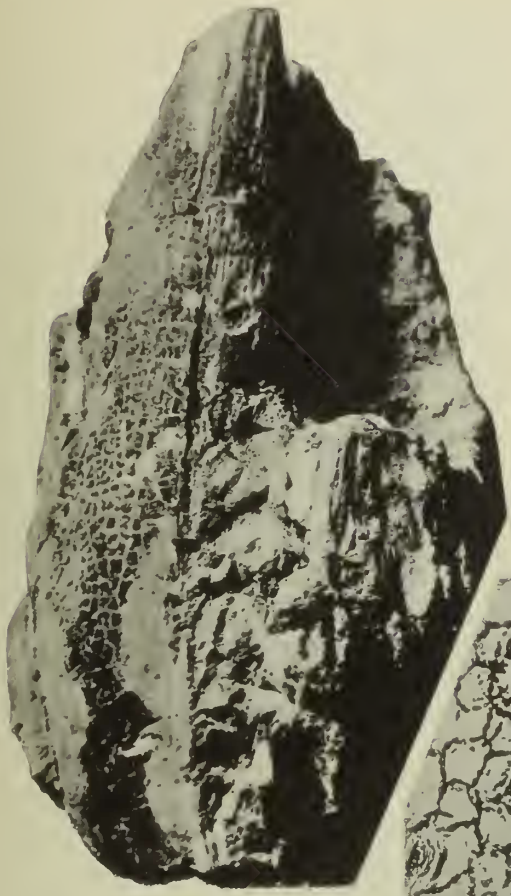
PLATE 15

Cycadolepis coriacea sp. nov.

FIG. 63. General aspect of bract. LIL 2593. ×2.
FIG. 64. Same specimen. ×1.
FIG. 65. Cuticle of abaxial epidermis showing grouped hairs and stomata. BAPB 7924. ×200.

? ***Cycadolepis involuta*** sp. nov.

FIG. 66. Specimen from sandy sediment without cuticle. BAPB 7912. ×1.



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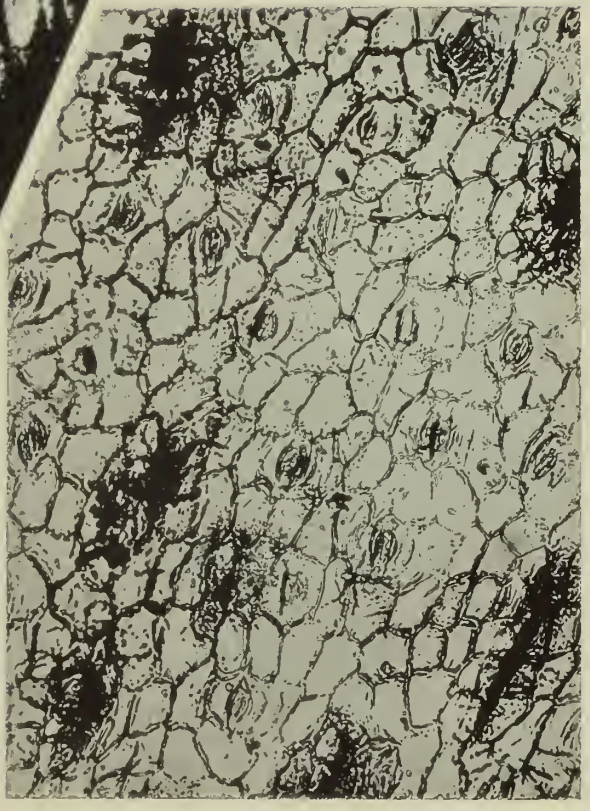

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PLATE 16

Cycadolepis involuta sp. nov.

FIG. 67. General aspect of bract. BAPB 7910. ×2.
FIG. 68. Same specimen. ×1.
FIG. 69. Cuticle of adaxial epidermis. BAPB 7910. ×200.
FIG. 70. Stoma of abaxial epidermis. BAPB 7910. ×1000.
FIG. 71. Cuticle of abaxial epidermis, showing stomata, small papillae and hair bases. BAPB 7910. ×200.

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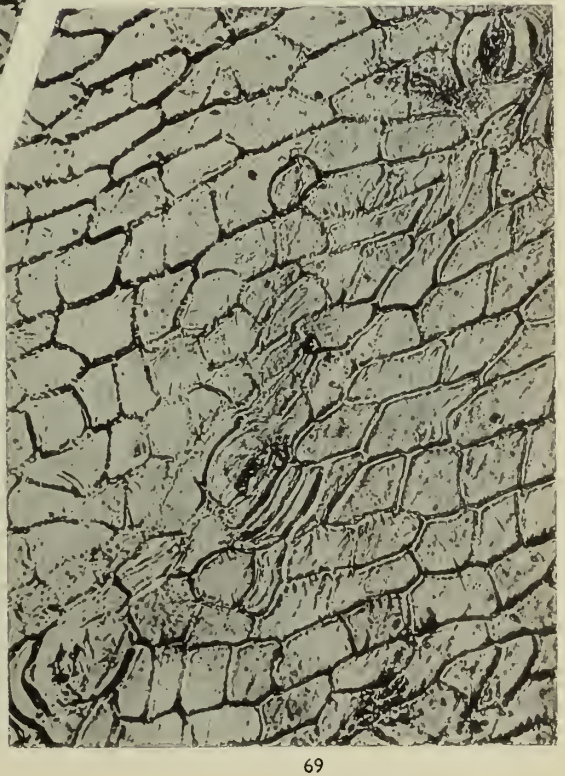

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PLATE 17

Cycadolepis cf. ***jenkinsiana*** (Tate) Seward

FIG. 72. Half lateral part of a bract folded in the middle. BAPB 7915. ×1.

FIG. 73. Cuticle of adaxial epidermis with stomata, sparse small papillae, isolated hairs and grouped hairs. B.M. (N.H.), no. V.45387. ×200.

FIG. 74. Stoma and grouped hairs. B.M. (N.H.), no. V.45387. ×1000.

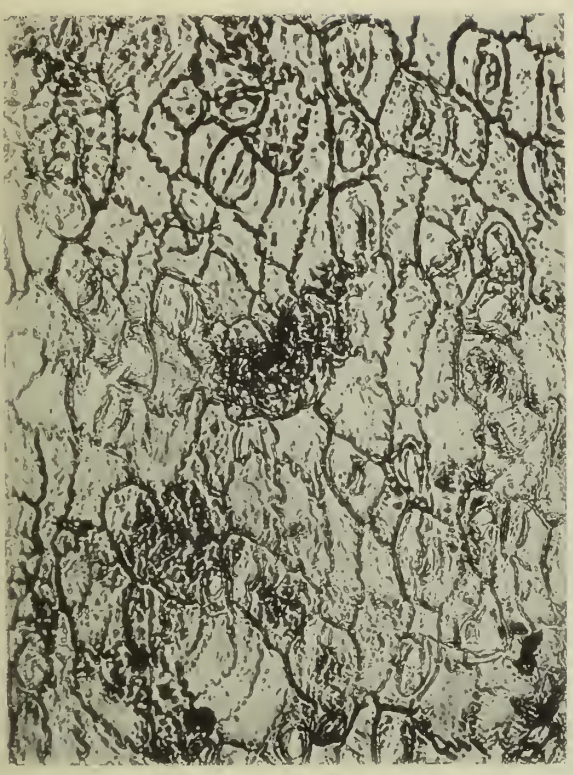

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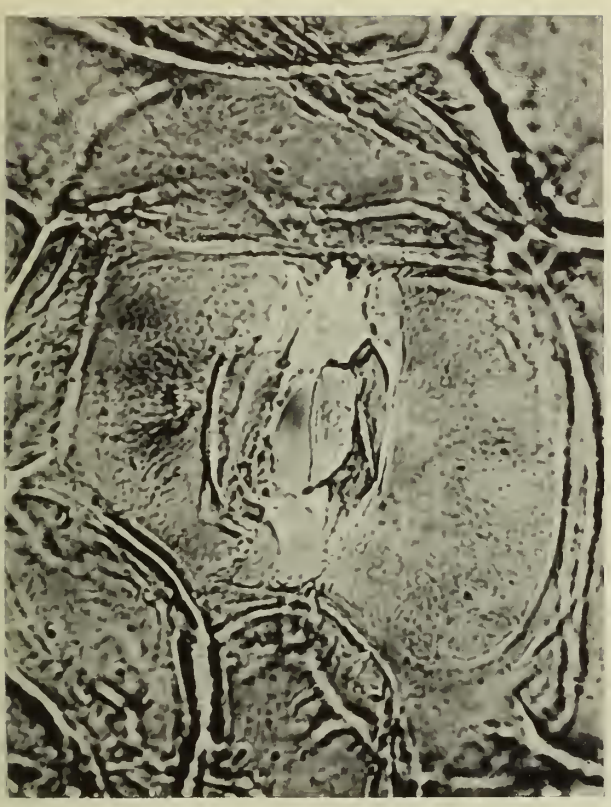
PLATE 18

Cycadolepis lanceolata sp. nov.

Fig. 75. General aspect of bract, with marginal hairs. B.M. (N.H.), no. V.45386. ×1.
Fig. 76. General aspect of holotype. Holotype, BAPB 7906. ×1·5.
Fig. 77. Same specimen. ×1.
Fig. 78. Cuticle of adaxial (left) and abaxial (right) epidermis of holotype. ×200.
Fig. 79. Stoma of abaxial epidermis of holotype. ×1000.



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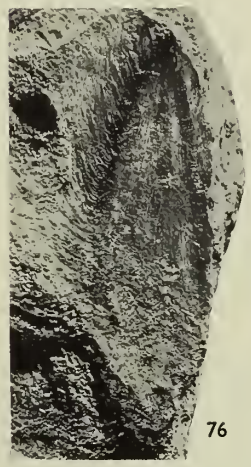

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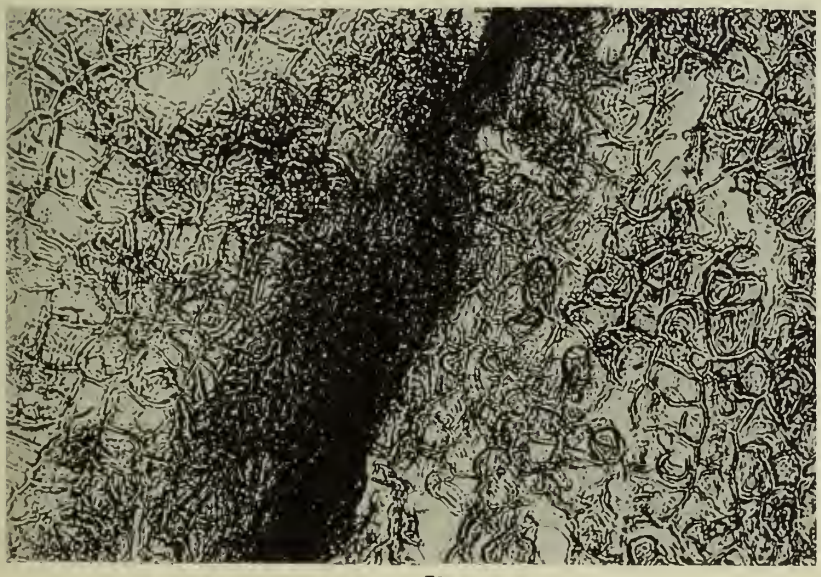

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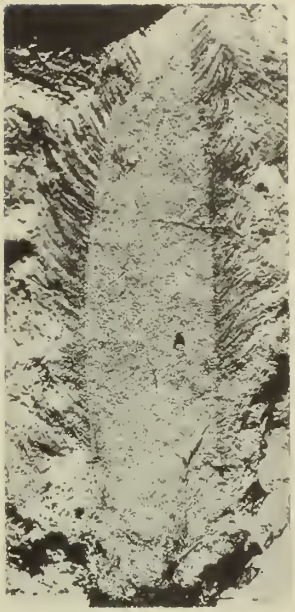
PLATE 19

Cycadolepis oblonga sp. nov.

FIG. 80. General aspect of bract with marginal ramentum. Holotype, BAPB 7907. ×2.
FIG. 81. Same specimen. ×1.
FIG. 82. Cuticle of adaxial epidermis with cells in longitudinal rows and transverse stomata. BAPB 7907. ×200.
FIG. 83. Cuticle of the abaxial epidermis of same specimen, with trichome bases, stomata and marginal trichomes (above). ×200.
FIG. 84. Stoma and trichome bases (above) of abaxial epidermis. BAPB 7907. ×1000.

81



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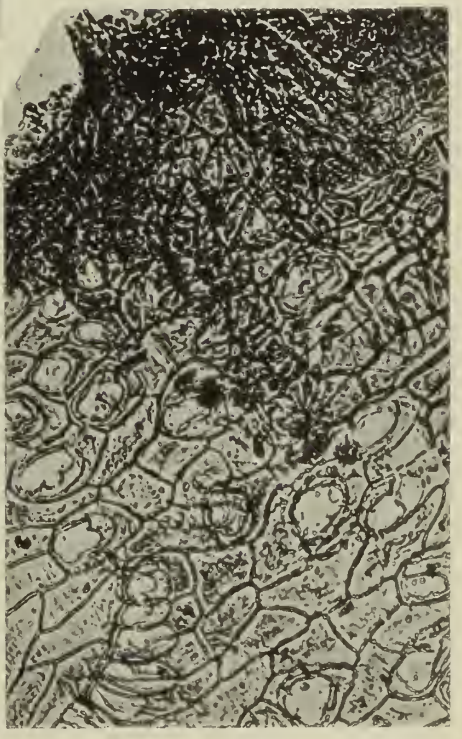

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